WHAT ARE GOOD AND EVIL?

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XI. No. 127. JULY, 1930. PRICE 1s. NET

ANCIENT MUMMY FROM PERU

(See page 215)

CHIEF CONTENTS.

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Trustees : Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

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Editorial Notes.

A new analysis of our subscription list shows that *Discovery* travels each month to more than forty countries. We have, of course, many readers in each of the Dominions, but copies also go as far afield as Bangkok, Buenos Aires, and Tahiti. Arising out of this world-wide distribution, we receive many interesting letters : in particular, articles on tropical science always bring us comments from overseas readers. Foreign correspondents, on the other hand, are usually deterred by the language difficulty from sending us their views, but a notable exception must be recorded this month. On another page we print a communication from a Danish reader, who, prompted by a recent article on bird-marking, has forwarded us new data of great importance, hitherto kept secret even from ornithologists. As most people know, the chief source of information on bird migration is "ringing." Birds caught at various stations are marked with distinctive rings, which indicate the duration and length of flight when the birds are recovered in other parts of the world. Pleading for the rationalization of this work, Mr. Nicholson suggested in *Discovery* that a station was needed in Iceland, an important centre of bird life. Now comes the news that ringing is already in progress there on a large scale, and the results are published for the first time in our columns. Mr. Skovgaard's ringing station in Denmark is recognized as one of the foremost in Europe, and Iceland is Danish territory. The work is thus a natural extension, but up to now it has been unknown to investigators elsewhere. Apart from the value of the statistics themselves, the new facts they reveal about bird habits will interest a very wide public.

* * * * *

A suggested alteration in the law governing medical patents has given rise to the keenest discussion among doctors and chemical research workers. Under the new law, the inventor of a medical preparation would receive no monetary reward so far as his rights in this country are concerned. He would be entitled instead to a free licence, other licences to be granted by proposed Medical Patents Trustees for a consideration, such consideration to revert to the Trustees and not to the inventor. Those supporting this change urge that it is ethically undesirable for medical practitioners conducting research to derive financial benefit therefrom. Others strongly disagree with this view. Dr. Renshaw, for example, writes in the *British Medical Journal* that there is no essential difference in the nature of the service to mankind between the skill of the laboratory worker and that of the surgeon who, for his skill, takes a fee. "If the research worker can, by his skill and ingenuity, add to the sum of human happiness and health," he asks, "why should he not be paid, when the administrator of a public health service, who may utilize his results, is paid for so doing?" We think that the best solution is suggested by the Joint Chemical Committee, which holds that the abandonment of medical patents should not be adopted until international agreement has been obtained. Otherwise both research workers and manufacturers in this country would be placed at a very considerable disadvantage.

* * * * *

Further progress in physical theory was announced by Professor Einstein last month, when he gave an address to the world Power Conference in Berlin. The occasion was interesting on account of a new speaking apparatus, used for the first time, by which the lecture could be heard in any of three languages. (Photographs on another page show the apparatus at work.) The title was "The Space, Field, and Ether Problem in Physics." As was expected, the address was extremely technical and only expert

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mathematicians could appreciate its significance. According to an official report, however, the Professor summed up the position as follows : " Metaphorically speaking," he said, " space which had been abstracted from material objects and made a scientific reality by Newton has, during the past century, swallowed up both ether and light, and is about to swallow up both the gravitational and electro-magnetic fields and corpuscles as well, so that it will be left as the sole theoretical representative of reality."

* * * * *

A well-known cartoonist, in connexion with the Simon Report, recently showed India as a giant elephant. " All we have to do," the Government was saying, " is to place him on the operating table." What gave the artist the idea we do not know, but actually an elephant *was* treated in this way not long ago. The animal, a captive beast employed on a rubber estate, had become restive and dangerous, owing to what appeared to be the lodging of a foreign body in his head. Accordingly arrangements were made to have Jumbo X-rayed. After a march in easy stages he reached Columbo General Hospital, where he was examined in the presence of a large body of the medical profession, press representatives, and other spectators. There was a nervous moment when the elephant tried to touch the delicate Philips X-ray apparatus with the tip of his trunk, but he remained passively philosophical during the examination. The photographs revealed a small bullet, probably fired at him during his wild career in the jungle, which had penetrated his skin near the ear. It was later successfully removed.

* * * * *

How a ruthless war against insect pests in every part of the Empire is being directed from a headquarters in a Buckinghamshire village is described in a report just issued by the Empire Marketing Board. A converted country-house at Farnham Royal, near Slough, is used as a clearing station and breeding centre for " beneficial " insects. These are dispatched to the Dominions and Colonies to attack their harmful brothers, who cause an enormous loss to agriculture. In the three years of its existence, this " Parasite Zoo " has been asked by overseas Governments to investigate some seventy different kinds of insect and weed pests, in the hopes that parasites may be found. Damage done by insects is extremely costly. Blowflies, for instance, annually destroy about five per cent of the sheep population of Queensland, and are estimated to cost Australia £4,000,000 a year. The insect toll is likely to grow bigger in future. The majority of the serious pests are not native to the countries they now infest. They were introduced, accidentally or otherwise, by man, and the more we foster Empire trade, the more opportunity we give to injurious insects to move from one part of the Empire to another. Cunning devices have been invented by entomologists to deal with the problem. One of these is called a " bouncing machine." Tiny insects' eggs are allowed to run down a wooden chute and bounce off a small piece of tin at the bottom. An egg which has been " parasitized "—that is, which has another egg, laid by the parasite, inside it—does not have the same capacity for bouncing as do healthy eggs, which jump into a further tin and so are separated for laboratory purposes.

* * * * *

The possibility of establishing an Arctic air route between Britain and Canada will be carried a stage further this summer. On 3rd July an expedition will leave England to explore the Arctic ice cap of Greenland, under the auspices of the Royal Geographical Society and various Government interests. The party will sail in the *Quest*, at one time used by Sir Ernest Shackleton, and is being led by Mr. H. G. Watkins, of Cambridge. The special advantage of the proposed route is that the longest stretch of flying over the sea which it involves is only three hundred miles.

* * * * *

The wireless telephone service to ships at sea, established by the Post Office experimentally last February, is making excellent progress. Before long it is probable that passengers on any of the principal liners will be able to ring up telephone subscribers in almost any country in the world. Meanwhile, the remarkable quality of the service already working was shown last month when the B.B.C. broadcast a conversation between a passenger on the *Homeric*, in mid-Atlantic, and a speaker in the London studio. Every word of the passenger's description of the scene on the liner was as clearly heard as the questions and comments put to him from London. The absence of the annoying hum or crackling, which sometimes ruins long-distance telephony even over wires, was particularly noticeable.

* * * * *

The following conversation is reported in the Oxford *Isis*. We think it may form a suitable footnote to our paragraph about Einstein !

FIRST DON : I say there is *no* meaning in meaning.

SECOND DON : You mean no meaning in what meaning is meant to mean.

FIRST DON : I don't. I mean there may be meaning in what meaning is *meant* to mean but no meaning in what meaning *means*.

SECOND DON : Ah, yes ; now I see what you mean.

Mummy Mining in Peru.

By A. Hyatt Verrill.

The mining of human remains has been an established Peruvian industry for hundreds of years, in the course of which countless mummies have been disinterred. The country is still proving an important field for archaeological research, and the remains of ancient races are continually brought to light.

EVER since the days of the Spanish conquest, mining mummies has been a more or less lucrative industry in Peru. Not that the mummies themselves were desirable or valuable, but because the Incans and pre-Incans interred ornaments, weapons, utensils and implements with their dead, and some of these were of gold or silver. How many tens of thousands of mummies were thus destroyed no one can guess. In addition to the countless mummies dug up by the professional *huaqueros*, as they are called, thousands of bodies have been disinterred by archaeologists, curio-seekers and others, while thousands more have been destroyed in the course of constructing railways and roads, digging irrigation-ditches, cultivating land and carrying on various public and private works.

A PRE-INCAN MUMMY.
This specimen was discovered clad in its ceremonial robes and adorned with golden ornaments.

One would think that, years ago, the supply of mummies would have been exhausted. But so vast was the number of dead buried in Peru that, despite all that have been disinterred, practically no impression has been made, and what is more, scientists are continually finding mummies and remains of hitherto unknown people and cultures. No one would dare to estimate the number of mummies that were buried or that yet remain even in a small area of the country. From Ecuador to Chile and from the coast to beyond the Andes there is scarcely a square mile without its cemeteries, its mounds or its ruins filled with dead. Many cemeteries cover hundreds of acres; many burial-mounds are stupendous; and in many ruined cities every available piece of ground is filled with mummies. The Huaca Juliana, just outside of Lima—nearly half a mile in length, nearly a quarter of a mile wide, and over one hundred feet in height—is made up of countless brick cubicles containing mummies, and this is but one of numerous equally huge burial-mounds in the vicinity. The new urbanization developments about Lima are surrounded by burial-mounds; one of the new highways cuts through the centre of an immense mound filled with mummies, and a suburb has been erected over ancient graveyards. It is not unusual to see a modern residence with scattered skulls, scalps, mummy-wrappings and bones within a few feet of the front door, and in cultivating their flower gardens the residents are as likely to turn up skulls as stones.

Obviously the majority of the mummies are those of poor and humble peasants, for as a rule the mummy-bundles contain very little of value or interest. Stone, shell or clay ornaments, an occasional stone implement, gourds filled with corn, peanuts or other food; baskets of needles, thread and weaving implements, pouches filled with cotton seeds, llama-hair slings and cotton spindles are the usual objects found, together with pieces of pottery and various kinds of cloth. But if one is fortunate enough to disinter the mummy of a chief, priest or medicine-man, a wonderful collection of archaeological treasures may result. At times they are found with elaborate head dresses of feathers; there is usually a mask or false face of painted inlaid wood or even of silver or gold; there may be bows and arrows, ceremonial staffs, spears with bronze tips, *atlatls* or spear-throwing sticks and ornaments

of silver and gold. From one grave I obtained a magnificent bronze battle-axe with handle complete, a most effective weapon still capable of slicing a man's head from his shoulders or cleaving his skull; the star-headed maces of stone or bronze, as well as bundles of *quipos* or message-strings, are quite common. If the mummy is that of a woman there will be work baskets, looms—often with partly woven textiles upon them—carded and dyed yarn, and sometimes gowns and shawls of the most delicate and beautiful lace, all so perfectly preserved that they might have been buried only yesterday instead of thousands of years ago.

In most of the coastal districts—especially in the Rimac Valley—I should say that not one in five hundred mummies is accompanied by any objects of intrinsic value, and that not one in a hundred has anything unusual as far as textiles, pottery, feather-work or utensils are concerned. Yet in other parts of Peru the proportion of richly decorated mummies is very large, and in a few localities they preponderate, while in only one known district are all these so far discovered of this type.

Despite all the archaeological work that has been done in Peru during many decades, we really know little of the ancient cultures. No one positively can say whether they all had a common origin or whether they were distinct and each race developed its independent culture. No one can assert with certainty which is the most ancient. Even the origin and history of the Incas—the most recent of all Peruvian cultures—are shrouded in mystery and uncertainty. All we do know is that in many places one culture is superimposed on another, and by the stratification of the remains we can determine the chronological order in which they were developed. Constantly we are greeted by the most amazing surprises and discoveries that often—I might say usually—result in adding to the mysteries and puzzles we are trying to solve.

This was the case in the Nasca district of southern Peru. Probably no other ancient Peruvian culture was, or was supposed to be, so well known as that of the Nascans. Practically every museum and private collection in the world contains specimens of Nascan ceramics, textiles and featherwork. Of all known aboriginal American pottery the Nascan holds first place for its beauty and perfection. Of equal beauty and perfection are the Nascan textiles and featherwork, and as a rule these are perfectly preserved with colours as fresh as when first made. This is due mainly to the fact that the Nascans buried their dead in genuine tombs instead of in graves. Each body, when of a prominent personage, was wrapped in cloths and swathed in textiles until a bundle several times the size of the body was formed. This was then arrayed in the finest of robes, ponchos, belts and textiles, adorned with silver or gold ornaments, and was provided with a mask and false head covered with human hair. It was then crowned with a gorgeous feather head dress, and the whole was enclosed in a cocoon-like wrapping of coarse cloth.

Opening a Nascan tomb is very different from digging up a mummy in a desert or a mound. Fragments of shards, bones and rubbish mark the burial-places, and the tombs are indicated by the tops of vertical posts. Below the loose superficial sand and pebbles is a small platform of sticks under

TERRA-COTTA GRAVE GODS.
It is supposed that these grotesque images of women, found in the tombs of Peru, represented the wives of the men with whom they were buried.

which is more gravel. When this has been removed for a depth of several feet a strong structure of timbers covered with stones is revealed. This is the roof of the tomb, a large square room walled with stone and adobe, and often as large as a good-sized hut. Placed upon the floor are pots, *ollas* and vessels of the beautiful Nascan ware, and in the corners, resting backs to walls, are the huge shapeless bundles each containing a mummy.

Owing to the beauty of the Nascan objects and to the abundance of precious metals in the tombs, more systematic mummy mining has been done in the Nascan area than in any other portion of Peru, for Nascan specimens always find a ready sale and professional *huaqueros* have always been able to turn an honest penny by disposing of the textiles and ceramics, even when no gold or silver rewarded them.

FROM A WOMAN'S GRAVE.

A loom, with a partly completed tapestry in the conventional fish design of pale blue, grey and buff.

Yet despite this, despite the fact that practically every archaeologist who has ever visited Peru has had a fling at mummy mining at Nasca, and despite the fact that all agree the culture was unique, that it was confined to a limited area and that no other culture (other than the late Incan) occurred near Nasca, recent discoveries have completely upset all these ideas and have proved that not only was there a pre-Nascan culture, but a pre-pre-Nascan culture totally distinct from the true Nascan. These discoveries bear out what I have said regarding the ever-present chances of making epochal discoveries, even in the best-known districts of Peru.

Not only were the tombs of the pre-Nascans distinct from those of the Nascans, being cylindrical instead of rectangular, but the textiles, the pottery and the mummies were very different. As many of the Nascan burials were above the others there is no question that the Nascans were the more recent. To what extent the latter were influenced by their predecessors it is impossible to say. In some respects there is a similarity in design, in colours and in *motifs*, both in the textiles and ceramics, yet they are always distinct and easily recognized. No Nascan pottery can compare with that of the pre-Nascan. In one spot countless thousands of potsherds were found—fragments of vessels wantonly destroyed by the Spaniards. These were collected and when, with infinite labour, they were pieced together, they formed jars and bowls several feet in height, often two inches or more in thickness and completely covered, often inside as well as outside, with most intricate and beautiful designs in the colours for which Nascan ware is famed. Even more remarkable and unique were the pottery figures of llamas, two feet or more in height, beautifully modelled and coloured, and forming hollow vessels the openings of which were in the form of elaborately decorated cup-like vessels upon the animals' backs.

In another place—though still within the Nascan area—indications of burials were found, and excavations brought to light mummies such as no one had ever seen or imagined. Unlike those of the Nascans, these of Parakas were not in tombs, not even in true graves, but had been placed, as many as forty or fifty together, in huge pits or caverns and covered with sand. As the material was removed the mummies appeared more like conical, dun-coloured tents than mummy-bundles, for they were pyramidal in form and often six feet in height by six feet in diameter at the base, and bore no resemblance to human forms. They were so huge, so bulky, and so heavy that several men were required to lift or move them, and even the smallest were larger than any Nascan mummy-bundles. In the open air they could not safely be opened, but glimpses of their contents, exposed through rents in the outer wrappings, revealed textiles of remarkable beauty.

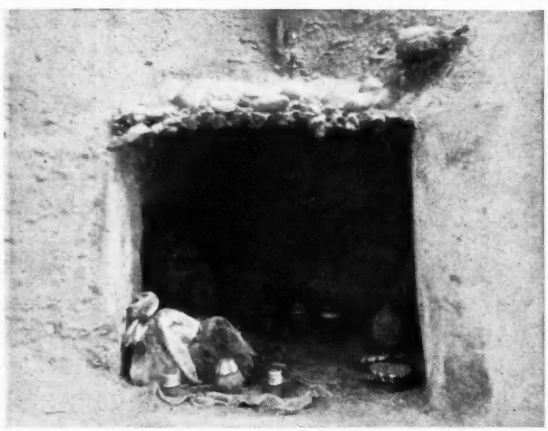
Apart from these great mummy-bundles there were specimens of pottery as unique as the mummies. Many were ornately decorated with incised designs combined with colours, others were painted in bright

yellow, green and blue with some pigment that gave the effect of oil colours; others were in the forms of fruits, vegetables, birds and animals, but all were of a type unlike anything hitherto known.

That these remains were extremely ancient was proved by representations of llamas with five toes instead of two as in the living species, and skeletons of five-toed llamas were found interred in the graves. Whether these people lived so long ago that llamas still retained five toes, or whether these llamas were a special breed, is undetermined. But at the lowest possible estimate the Parakas remains are at least two thousand five hundred to three thousand years old.

It was not until the mummy-bundles were unwrapped in the museum at Lima that anyone realized fully their tremendous archaeological value, the treasures they contained, or the epochal discovery that had been made; every bundle, in fact, was a little museum in itself. And with each section of wrappings removed our wonder and amazement increased. No two were alike in contents, and unwrapping them was like undoing a Christmas package, or a game of archaeological grab-bag. It was impossible to foretell what might be within the wrappings, for neither the size nor the external appearance of a bundle afforded any guide as to its contents, and very often the largest bundles held less than the small ones.

Moreover, instead of having the textiles, weapons, ornaments and other objects all together, as is the case with other Peruvian mummies, these from Parakas are covered with a series—strata might better express it—of alternate wrappings and



A TOMB AT NASCA.
Nascan textiles and featherwork were found in perfect condition with the colours as fresh as when first woven.

DIGGING IN A BURIAL MOUND.
Mummy mining is dusty work, as this picture of operations among the tombs in the Rimac Valley clearly shows.

magnificent textiles together with the possessions of the deceased. There is no definite number of these wrappings—they vary from six to sixty or more—and as one never knows what the removal of the next wrapping may expose, the unwrapping of a Parakas mummy is extremely thrilling, at least to an archaeologist.

As a rule, when the outermost covering of rough white cotton cloth is removed, the bundle is found completely shrouded in immense, exquisitely coloured robes of fine woollen cloth with magnificent fringes. These are usually red and black—though sometimes of grey viscacha hair—woven with elaborate checks, stripes or squares, and almost completely covered with symbolic and highly conventionalized designs in yellow, blue and green heavily embroidered upon the surface. Covering the upper portion of the bundle is a short tunic or poncho of brilliant colours, while above this is an elaborate head dress of fox skin or other material and feathers. Often a collar or necklace of shells, stone beads or gold may be below this.

Carefully removing the textiles, the head-covering, the tunic and the robes, a second, a third and sometimes as many as twenty of the great embroidered shawls are revealed. Tucked among their folds are feather-fans, feather-wands, stone-headed maces, wooden ceremonial sceptres, ornaments of gold, carved stones, turquoise and shell. This, however, is only the beginning. Under the last immense robe appears a second shroud of white or brown cloth tied securely at the top to form a false neck and head, which is covered with a square of cloth, usually blue or brown. Unlacing the twine with which the shroud is held

in place, and stripping off the wrapping, another layer of brilliantly coloured textiles is disclosed. Very often these are as perfectly preserved as the first layer, but quite as frequently they are embedded in a mass of fine, dark-brown powder mingled with bits of fur and feathers, all that remain of what, thousands of years ago, were gorgeous robes and trappings.

Yet when this decomposed material is brushed and blown aside, perfectly preserved textiles are found in and beneath it. At this stage of unwrapping—provided there are not over eight or ten layers—the indistinct outlines of the body are visible through the coverings. Here also are usually the *maté*-bowls, the gourds of corn and beans; yucca-roots, potatoes and other food; stone weapons, pottery and gold ornaments. Finally, when the last covering is removed, the mummy itself appears, seated on its haunches and resting on its left side amid garments, utensils and cloths, and always in an immense shallow basket, while in some cases the basket-lid is found upon the stomach of the mummy. In the majority of cases the body is decked with gold ornaments, such as ear-plugs, necklaces, gorgets, collars, nose-rings, and head ornaments.

THE QUICK AND THE DEAD.
Suburban residences have been built upon the ancient graveyards of Lima, and are surrounded by bones and skeletons.

Of all Peruvian mummies those of Parakas are the best preserved, for unlike the others they were carefully and skilfully embalmed or mummified before burial. All the viscera and softer portions of the anatomy were removed, the larger muscles were dissected through incisions in the skin, the tendons were severed at the joints, and the entire corpse was apparently immersed in some chemical—probably a saline solution—and afterwards dried and smoked before burial. Very possibly the bodies were preserved for months or even years before burial, for it would require a very long time to weave and embroider the immense burial-robes, and as none of these show any signs of use we must assume they were made solely for burial purposes. If made after a death took place it is obvious that the body must have been preserved elsewhere until the robes were completed; but, of course, they may have been woven years in advance and laid aside in readiness for the owner's end. Or, again, they may have been religious or ceremonial robes kept in temples and intended only for burial-robes. The objection to this theory is that each mummy is surrounded with robes, ponchos, tunics, cloths and turbans all of the same colours and designs, perfectly matched and distinct from those on any other mummy. So it is clear that they must have been designed especially for each individual.

No words can do justice to the beauty, the colours or the quality of these textiles, with designs that, repeated over and over again and completely covering a robe eight or ten feet square, never vary by so much as a stitch or a thread in size, colour or pattern. So close and even is the embroidery that only by a most painstaking examination with a lens is it possible to determine that it is embroidery and not weaving. Moreover, these people were, apparently, the only ancient Peruvians who possessed a pictured or recorded calendar. On some robes the border is composed of symbolic figures so arranged that, almost beyond question, the design served as a calendar showing days, months, and the four seasons of the year.

At every turn, when studying the Parakas material, one comes face to face with insoluble mysteries. Who were these people? We know from their skeletons that they were far larger than other Peruvian races, for many of the men stood over six feet in height, while some of the women were almost as tall. Although an agricultural race, they were no mean warriors, for their stone weapons were beautifully made, and trophy-heads—heads artificially preserved, and with lips and eyelids sewn together—are not uncommon.

All the mummies so far found have been chiefs, priests, nobles or kings and their women. Not a single one was the body of a peasant. Were all the Parakans wealthy, richly-clad nobles? And where are the ruins of their homes, their palaces and their temples?

There is but one answer. What we have so far found is merely one small group of burials devoted to the most eminent members of the community, and somewhere, near at hand, we may yet find remains that will solve all these mystifying puzzles.

First Bird-Marking Results from Iceland.

By P. Skovgaard.

*Mr. Skovgaard is the head of the important Danish organization for bird-marking at Viborg. In response to the suggestion*that a centre ought to be established at Reykjavik, he discloses the fact that bird-marking has recently been carried out on a considerable scale in Iceland, and with remarkable results hitherto kept secret. In order to explain the significance of these new data, we invited Mr. Nicholson to supply a series of notes, which are printed in brackets at the appropriate points.*

In Mr. Nicholson's article there are many statements and suggestions of great interest, and among them a proposal for a ringing station at Reykjavik. One already exists, or at any rate the work is rapidly developing in Iceland. Beginning with only one assistant in 1921, it has now the help of thirty-eight assistants in seventeen different districts, and has so far marked 4,464 birds. These have yielded hitherto 124 recovery records, of which 86 were outside Iceland including 54 from Britain. I therefore suppose the results may be of special interest to the readers of *Discovery* :—

Species Marked in Iceland.

(Re-arranged according to accepted British classification.)

	Number of Birds Marked.	Recovered.
Raven, *Corvus c. corax*	9	0
Hawfinch, *Coccothraustes c. coccothraustes*	1	0
Mealy (?) Redpoll, *Carduelis l. linaria*	1	0
Snow-bunting, *Emberiza nivalis* ...	45	0
Meadow-pipit, *Anthus pratensis* ...	338	2
White wagtail, *Motacilla a. alba* ...	234	2
Iceland Redwing, *Turdus musicus coburni*	160	0
Merlin, *Falco columbarius aesalon* ...	5	0
Gyrfalcon, *Falco rusticolus*	3	1
Whooper swan, *Cygnus cygnus* ...	?	0
Bean-goose, *Anser fabalis* (?)	6	0
Mallard, *Anas platyrhyncha*	58	0
Gadwall, *Anas strepera*	28	4
Pintail, *Anas acuta*	61	5
Wigeon, *Anas penelope*	294	31
Teal, *Anas crecca*	125	11
Tufted duck, *Nyroca fuligula*	52	1
Scaup-duck, *Nyroca m. marila*... ...	239	10
Barrow's goldeneye, *Bucephala islandica*	19	0
Long-tailed duck, *Clangula hyemalis*	155	2
Harlequin duck, *Histrionicus h. histrionicus*	49	1
Eider, *Somateria mollissima*	115	2
Common scoter, *Oidemia n. nigra* ...	57	3
Red-breasted merganser, *Mergus serrator*	60	2
Cormorant, *Phalacrocorax c. carbo* ...	1	0
Gannet, *Sula bassana*	?	0

*Put forward in Mr. E. M. Nicholson's article on "Rationalisation in Bird-Marking," *Discovery*, April, 1930.

Species Marked in Iceland—(*Continued*).

Great northern diver, *Colymbus immer*	2	1
Red-throated diver, *Colymbus stellatus*	3	0
Oystercatcher, *Haematopus o. ostralegus*	2	0
Ringed plover, *Charadrius hiaticula*	30	0
Northern golden plover, *C. apricarius altifrons*	341	23
Dunlin, *Calidris a. alpina*	110	0
Purple sandpiper, *Calidris m. maritima*	6	0
Iceland redshank, *Tringa totanus robusta*	58	0
Red-necked phalarope, *Phalaropus lobatus*	392	0
Whimbrel, *Numenius p. phaeopus* ...	174	3
Snipe, *Capella gallinago*	184	3
Arctic tern, *Sterna macrura*	409	0
Great black backed gull, *Larus marinus*	47	3
Kittiwake, *Rissa t. tridactyla*	50	0
Great skua, *Stercorarius s. skua* ...	9	0
Arctic skua, *Stercorarius parasiticus* ...	12	0
Razorbill, *Alca torda*	1	1
Guillemot, *Uria a. aalge*	89	0
Ptarmigan, *Lagopus mutus*	83	3

[In order to avoid confusion for British readers the scientific names are given according to the Check-List. A surprising feature of this impressive record is the recovery percentage of the Gadwall, Pintail, Wigeon, Teal, Scaup, and Golden Plover group, which would be creditable anywhere.]

Recovery Records Abroad of Birds Marked in Iceland.

(Dates in italics refer to recoveries more than a year after marking.)

Meadow-pipit.

1. Caught 29.x.29 at Oosthoven, Turnhout, Antwerp, Belgium.
2. Shot c. 19.xi.28 at Penaroyo, Cordova, Spain.

White wagtail.

1. Caught 5.ix.28 at Rockall.

[Rockall is a bare minute uninhabited islet (lat. 57° 40'N., 13° 30' W.), beyond St. Kilda. For a case of another first-year bird of this sub-species coming aboard twenty-four days earlier between Iceland and Rockall see *British Birds*, XXII, p. 124.]

Gadwall.

1. Shot 26.x.27 at Rye, Sussex, England.
2. Shot 27.i.29 at Currandulla, Co. Galway, Ireland.
3. Shot *12.ii.30* on Lough Glore, Co. Westmeath, Ireland.

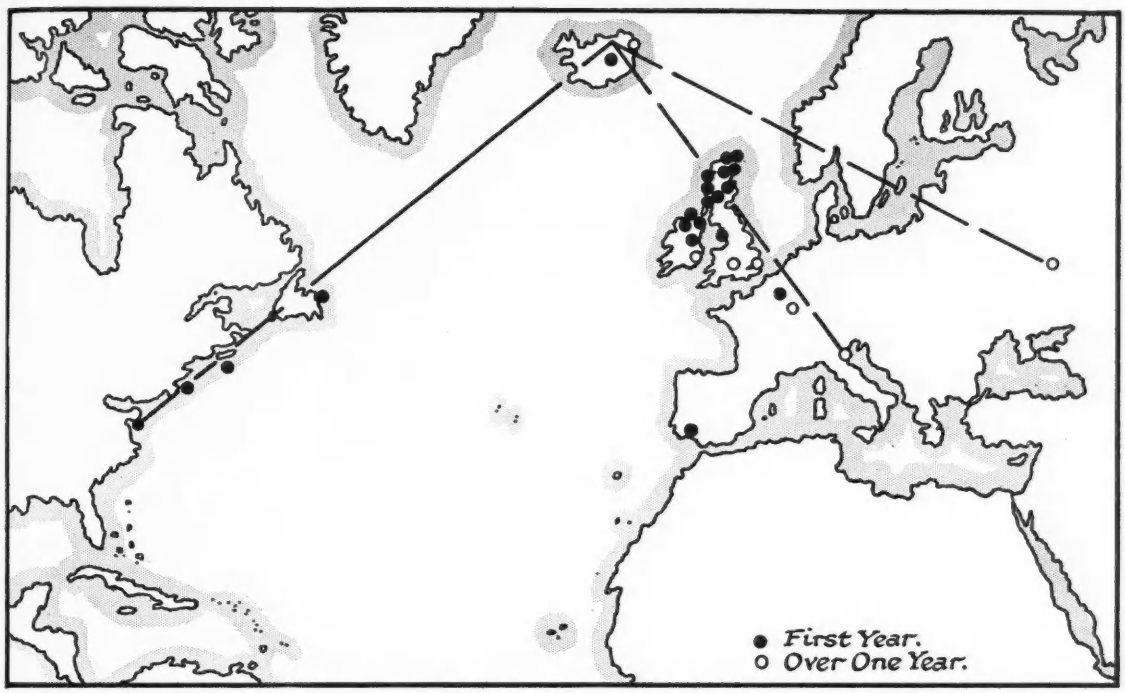


FIG. 1.

MAP SHOWING RECOVERIES OF WIGEON MARKED IN ICELAND.

Out of twenty-seven recoveries abroad on both sides of the Atlantic, eighteen are in the British Isles. Although longer distances have been flown by marked swallows, white storks, etc., no other case of such broad dispersal has so far come to light. (Birds recovered within one year of ringing and after are separately indicated.)

[The recovery of three birds in the British Isles out of only 28 marked in Iceland is a striking case, the dates suggesting strongly that this may be the normal winter quarters.]

Pintail.

1. Shot 25.ix.26 at Hornborgasjö, Västergötland, Sweden.
2. Shot 8.xii.27 at Clonmorayh, Rathangan, Co. Kildare, Ireland.
3. Shot *11. xii. 27* on L. Atalia, Co. Galway, Ireland.
4. Shot 16.i.27 at Ballydaheen, Castletown, Co. Cork, Ireland.

[The occurence in its first autumn near the Cattegat of a pintail native to Iceland is one of the most disturbing instances of the dangers of dogmatizing even from a considerable amount of marking data. Mortensen recovered 67 pintail out of 320 caught on migration at Fanö, Denmark, and a number of summer recoveries led to the conclusion that these were birds native to Scandinavia and northern Russia migrating to winter quarters south-west. The possibility is now open that some may actually have been Icelandic birds travelling by an unexpectedly circuitous route to their recovery localities in Italy and western Europe. The new position seems to be that while Icelandic pintail are now proved to winter in the British Isles it is no longer possible to assume from Mortensen's results that north European birds do the same, as Landsborough Thomson concludes ("Problems of Bird-Migration," p. 214). The Swedish bird, at the time when it was shot, must certainly have been still on its way to winter quarters.]

Wigeon.

1. Shot 16.ix.27 at Acnoba, Lochgilphead, Argyllshire, Scotland.
2. Shot *25.ix.29* at Holy Island, Northumberland, England.
3. Shot 15.ix.28 on Orkney Isles, Scotland.
4. Shot 28.ix.28 at Gerston Bog, Halkirk, Caithness, Scotland.
5. Shot 5.x.27 at Stephenville Crossing, Newfoundland.
6. Shot 8.x.28 at Lesmurdie, Morayshire, Scotland.
7. Shot 9.x.28 on L. Swilly, Co. Donegal, Ireland.
8. Shot 14.x.26 on Rio Macete, Huelva, Spain.
9. Shot 19.x.29 at Rogerstown, Co. Dublin, Ireland.
10. Shot *29.x.28* at Autrecourt on Meuse, Ardennes, France.
11. Shot 30.x.29 at Hamel, Nord, France.
12. Taken 2.xi.27 on Loch Eye, Ross & Cromarty, Scotland.
13. Caught *5.xi.28* in a decoy near Ipswich, Suffolk, England.
14. Shot 14.xi.27 at Great Pond, Eastham, Cape Cod, Mass., U.S.A.
15. Shot 27.xi.29 at Toomebridge, Co. Antrim, N. Ireland.
16. Shot 29.xi.29 at Colston Lake, Cambridge, Maryland, U.S.A.

*

17. Shot 1 xii. 29 at Hawk Point, Cape Sable Island, Nova Scotia.
18. Shot 6.xii.28 at Keiss, Caithness, Scotland.
19. Shot 14.xii.28 on Lough Foyle, Ireland.
20. Shot *23.xii.28* at Ravenna, Italy.
21. Shot 24.xii.26 on Loch Tarbert, Argyllshire, Scotland.
22. Shot 25.xii.28 at Laitburn, Invergordon, Ross & Cromarty, Scotland.
23. Shot *27.i.29* on Lady's Island Lake, Co. Wexford, Ireland.
24. Shot *1.ii.30* at Kirkwall, Orkney, Scotland.
25. Shot 15.ii.29 at Fleetwood, Lancashire, England.
26. Shot *8.iii.29* at Rugby, Warwickshire, England.
27. Shot 12.vii.28 at Bogorodizk, Tula, Russia.

[Bird-marking data provide no more conspicuous example of the value of the method than this series of recoveries, shown on the sketch-map in Fig. 1.

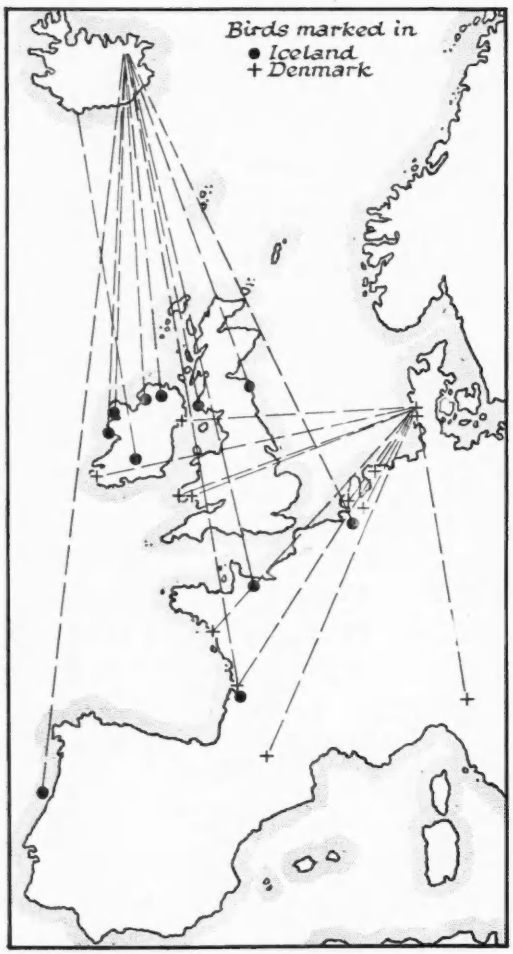


FIG. 2.
RECOVERIES OF TEAL.
This map shows recoveries of teal marked in Iceland and at Fanö (Denmark). The British Isles are here seen to be an area of concentration of birds native to two distinct areas.

It proves what has long been suspected that native Iceland birds may migrate habitually down both coasts of the Atlantic, a fact perhaps not irrelevant to the absence of geographical races among various species of holarctic duck. The fanning-out of birds from one small native area over nearly 30° of latitude and 110° of longitude is much the greatest recorded. It seems analagous to the double south-west and south-east migration of Central European White Storks *via* Spain or Asia Minor, but on an incomparably larger scale. The suggestion of a possible overland route to the Adriatic is also noteworthy. British native wigeon have covered some very long distances, but these data must place the species among the most remarkable migrants whose travels are at all accurately known.]

Teal.

1. Shot 20.viii.28 at Lawrencetown, Co. Down, Ireland.
2. Shot 25.x.27 at Varoville, Calvados, France.
3. Shot 30.x.28 on Longfield Flats, L. Foyle, Co. Londonderry, Ireland.
4. Shot 30.x.28 at Valado dos Frades, Portugal.
5. Shot *27.xi.29* at Cashel, Co. Tipperary, Ireland.
6. Taken by net 7.xii.27 at St. Ciers, Gironde, France.
7. Shot 10.xii.29 in Wigtownshire, S.W. Scotland.
8. Shot 14.xii.28 in Northumberland, England.
9. Shot 10.i.29 at Ballinasloe, Co. Galway, Ireland.
10. Shot *20.ii.29* at Ballacroy, Co. Mayo, Ireland.
11. Shot -.iii.29 at Rethy, Antwerp, Belgium.

[While only 14 British ringed wigeon out of 122 marked have so far been recovered, the material for teal is much more substantial, amounting under the *British Birds* scheme to 88 records. Although many of these refer to birds marked as adults on passage as well as natives recovered in Norway, Sweden, Denmark, Finland, Germany, and Russia, the extensive traffic to Iceland had not been brought to light from this in estigation. The sketch-map (Fig. 2) showing some Danish records in addition to the Iceland ones could be amplified to the point of unintelligibility by adding all available British data. It does, however, show clearly the position occupied by the British Isles as a winter reservoir for breeding teal, not only of home-bred stock, but of native areas far to the north-east, *via* Denmark, and north-west, in Iceland. In contrast with the wigeon, which shows an enormous south-east and south-west spread from a compact summer centre, the teal appears to make a moderately broad north-east and north-west fan from limited winter quarters.]

Tufted duck.

1. Shot *11.viii.28* at Northwich, Cheshire, England.

Scaup-duck.

1. Caught 12.x.28 on Hoornsche Meer te Horn, Holland.
2. Shot *30.x.26* at Belfast, N. Ireland.

3. Shot 10.xi.28 at Duncormick, Co. Wexford, Ireland.
4. Shot 30.xi.28 at Kampen on Zuider Zee, Holland.
5. Shot -.i.28 at Monbach, near Mainz on Rhine, Germany.
6. Shot *23.i.29* at Belfast, Ireland.
7. Shot 3.ii.30 at Makkum, Friesland, Holland.
8. Found c. 15.ii.29 at Trewern, Newbridge, Cornwall, England.
9. Shot 23.ii.29 at Tillysburn, Co. Down, Ireland.
10. Shot *3.viii.29* on Nigg Bay, Killary, Ross & Cromarty, Scotland.

[Iceland is one of the more important breeding-areas of this northerly species, and these records suggest that it is from Iceland that large numbers of the scaup-duck wintering in the British Isles may come. Scaup appear freely on the eastern portion of the Mediterranean, and the three recoveries of Icelandic birds from the Rhine basin indicate the possibility of an overland route south-east across Central Europe, although no doubt Arctic Russia and Siberia supply the bulk of the wintering stock in the Levant-Caspian-Persian Gulf area.]

Long-tailed duck.

1. Shot 27.v.29 at Christianshaab, Greenland.

[Christianshaab is on the west coast, on Disko Bay, comfortably north of the Arctic Circle, and of any point in Iceland. A bee-line from the place of marking would lead straight across the ice-cap; more likely the coast would have been followed by Cape Farewell. The date is noteworthy, for laying has begun in Greenland by 1st June: there is thus a suspicion of *abmigration* (or adoption of a fresh summer area distant from the native one) such as has been detected in various species of European duck.]

Common scoter.

1. Shot 24.x.27 at Ponta Delgada, St. Miguels, Azores.

[Previous records of European marked birds from the Azores include a British black-headed gull and a Dutch Spoonbill—see Landsborough Thomson, p. 231.]

Red-breasted merganser.

1. Shot *20.ii.30* at Lemmer, Friesland, Holland.

Northern Golden Plover.

1. Shot 12.x.29 on Canal de Lucon, near La Rochelle, France
2. Found 21.x.27 at Tullarvan, Kilkenny, Ireland.
3. Shot 22.x.27 at Ballinasloe, Co. Leitrim (?), Ireland.
4. Shot -.*x.29* in Ireland.
5. Shot 3.xi.26 at Bihoues, Coudarn, Gers, France.
6. Shot 4.xi.26 in Offaly, Ireland.
7. Shot 1.xii.29 on Solway Sands, Wigtown, S.W. Scotland.
8. Shot 15.xii.29 near Lisbon, Portugal.
9. Shot 26.xii.29 at Cloughmills, Co. Antrim, Ireland.
10. Shot 6.i.30 at Hornby Castle, Lancaster, England.
11. Shot 6.i.30 at Hairpin Island, Garringaloe, Co. Cork, Ireland.
12. Shot 30.i.28 on Spanish Island, Baltimore, Co. Cork, Ireland.
13. Shot 1.ii.28 at Dooyork, Geesala, Ballina, Co. Mayo, Ireland.
14. Shot c. *3.ii.30* at King's Lynn, Norfolk, England.

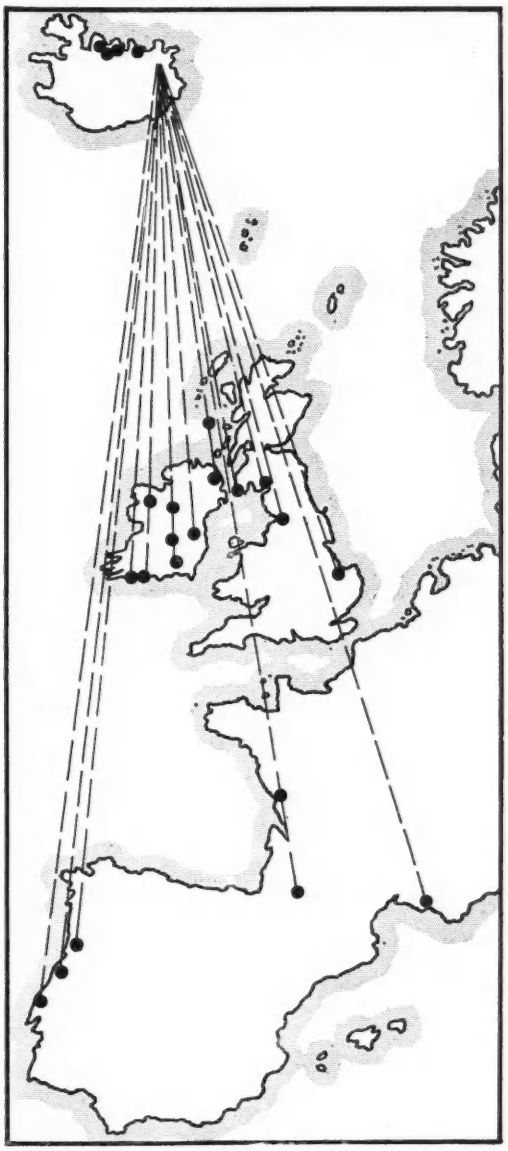


FIG. 3.

RECOVERIES OF GOLDEN PLOVER.

These birds were marked in Iceland and their narrow belt of distribution may be contrasted with the broad fan shown by the wigeon (Fig. 1).

15. Shot 16.ii.29 at Walada do Ribotejo, Portugal.
16. Shot (? date) at S. Martinho do Porto, Leiria, Estremadura, Spain.
17. Taken 22.ii.30 at Moniaive, Dumfriesshire, Scotland.
18. Shot 17.iii.29 on L'Etang de Berre, Bouches-du-Rhone, France.
19. Shot 12.iv.29 on Tiree, Inner Hebrides, Scotland.

[Golden plover of various races are amongst the best-known long-distance migrants in the world, but comparatively little marking work has hitherto been done on them: in this country, in fact, it has taken twenty years to mark 108 birds. The encouraging series of records here provided shows a curiously narrow north-and-south path, and raises the same problem as the Scottish Lapwing results; whether the birds wintering in Spain and Portu l get there *via* Ireland and the Bay of Biscay, or whether Ireland is simply an alternative destination, the rest travelling through England and by the west coast of France?]

Whimbrel.

1. Shot 11.ix.27 at Rochefort-sur-mer, Charente Inf., France.
2. Shot 21.x.28 at Dakar, Senegal, W. Africa.

[Whimbrel being for the most part passage migrants through the British Isles, cannot be marked by us on a satisfactory scale. Although no Iceland marked birds are yet recorded, there can be little doubt that this country lies on their normal route.]

Faroe Snipe.

1. Shot c. 5.xi.29 at Claremorris, Co. Mayo, Ireland.
2. Shot -.ii.30 at Ballina, Co. Mayo, Ireland.

[The distinct geographical race of snipe inhabiting Iceland and the Faroes was only finally accepted in 1923, and similarities of northern Scottish specimens have hindered recognition in some cases. This conclusive evidence of the presumed migration has therefore a certain value to students of geographical variation. Scottish marked snipe also migrate to some extent in winter to western Ireland.]

Greater Black-backed gull.

1. Found 3.i.29 on North Uist, Hebrides, Scotland.

[The sketch-maps show recovery localities outside Iceland. It should be understood that lines connecting the places of marking and recovery are inserted purely for convenience, and are not to be taken as representing the route by which the journey was made.]

* * * * *

To Mr. Nicholson's article I should like to add some remarks. The area now reporting birds is greater than that shown on his sketch-map (April, p. 119). I can add the rest of the African west coast, Greenland, and Iceland. The separate stations are collaborating as much as possible in order to search out birds reported which may have been overlooked by the station of origin. I wonder that the following ringing stations are overlooked by the author: Stockholm, Tartu, Riga, Brussels—further the stations which Roumania and Spain are preparing.

I fear that there will be many difficulties over collaborating under unified direction, and laying down the law regarding ringing in the separate countries will, I fear, only make difficulties for the stations, and seems not to be needed.—P. SKOVGAARD.

[The sketch-map referred to was, of course, only intended to give a rough idea of the regions covered by bird-marking schemes: the additions which Mr. Skovgaard's personal experience enables him to make are nevertheless very satisfactory, as bridging the two chief gaps indicated. There are various other marking stations extant, in addition to those mentioned in the original article, or now added by Mr. Skovgaard, but exhaustiveness was not aimed at, my original list (on p. 117) being expressly restricted to stations working on a useful scale—*i.e.*, those with over 10,000 marked birds to their credit. Small stations, or those which do not publish their records, are of doubtful utility to ornithology, as the article sought to show. With reference to Mr. Skovgaard's claim that collaboration is already practised as far as possible, it must be agreed that there is much to be said for private freedom of action; nevertheless, the fact that the important work carried out in Iceland is now made available for the first time to British ornithologists, who have done much to secure these records under the impression that they were Danish birds, is the best proof of the urgent need for a real pooling of resources in bird-marking. I should like personally to thank Mr. Skovgaard for his very generous response to my appeal for a better understanding, and for the trouble he has taken to make these extraordinarily interesting data available for English readers.—E. M. NICHOLSON.]

Cruises to the Tropics.

COMPARATIVELY few parts of the world may still be described as "unexplored," and the only regions of this character easily accessible by ordinary travel routes are in South America. The most interesting to the naturalist is the Amazon River, which flows through the largest tropical forest in the world. At the eastern end of this belt of forest lies British Guiana, which has recently been brought to the notice of scientists by the work of the Oxford University Expedition. The port of call here for the Harrison Line steamers is Demerara, other calls on this route being made at Barbados, Grenada, and Trinidad. Two weeks after leaving London the voyager reaches Bridgetown, which presents a vivid first impression of the tropics. A combination of sea and river cruise is available on the Booth Line, whose steamer *Hildebrand* crosses the Atlantic before proceeding a thousand miles up the Amazon itself. Particulars are announced of special winter cruises.

Colour-Change in Crustacea.

By M. Stephenson, M.Sc.

Department of Zoology, University of Birmingham.

The mechanism of colour-change in shrimps, prawns, etc. was unknown until recently, and its discovery forms an interesting chapter in biological research. Visitors to the seaside can easily study these changes.

A NUMBER of Crustacea have the power of changing colour with relative quickness, but shrimps and prawns, well-known to naturalists and fishermen, show this capacity in as striking a way as any, and have been most studied in this respect. The most striking colour-change is shown by *Hippolyte varians*, a little creature less than an inch in length, found clinging to weeds in rock pools. Green, brown, and red forms are known, found amongst seaweeds the colour of which they resemble. If they are shaken from their own colour of weed and placed in an environment composed of various coloured weeds, they instantly seek shelter in the weed most like their own colour. But if, for instance, red *Hippolyte* are given green weed only, they will, after a lapse of some days, become bright green themselves. The change is so extensive that, in nature, young forms which have taken to a habitat of one colour probably keep to this throughout life.

Whatever colour the prawn may exhibit during the day, at nightfall that colour is withdrawn; the body becomes transparent and tinged with bright blue, giving the animal a most ethereal appearance. This diurnal rhythm is so strong that it will persist for days, even though the prawns are forced to remain in continuous light or continuous darkness.

The forms most commonly met with around our shores are the common shrimp, *Crangon vulgaris*, various species of *Leander* and *Palaemon* (*P. serratus* is the prawn of the market) and the little *Palaemonetes varians*, often found in estuaries. The change shown by these forms is less striking than in the case of *Hippolyte*, but quite well-marked. *Crangon* is exceptional in the possession of a dark brown (melanin) pigment which makes the creature in its dark condition appear almost black, in its light condition a pale mottled sandy colour. In the case of *Palaemon* and its kindred, the body is normally transparent, this fact being more or less emphasized according as the animal is in its dark or light phase. In the light phase it appears to be colourless; in the dark phase it is banded and looks rather more opaque.

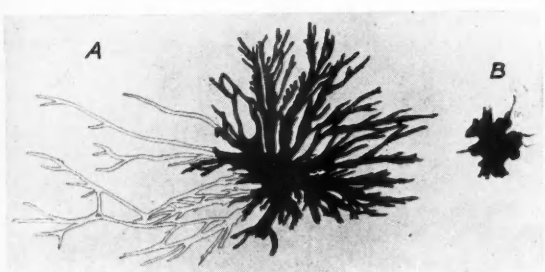


FIG. 1.
EXPANDED AND CONTRACTED CHROMATOPHORE.
A, expanded; B, contracted chromatophore of *Palaemon*. Red pigment is shown as black, yellow pigment as white.

Response to Environment.

In nature, the light phase is assumed when the creature is on a pale background, such as sand or chalk; practically nothing is visible but the eyes, the general outline being lost. But animals taken from a district with dark rocks and weed will have a dark or mottled appearance and so will merge with the background. Either change puts the animal in harmony with its environment, and renders it inconspicuous, to our eyes at least.

This colour-change is made possible by the presence of chromatophores lying in the skin beneath the transparent shell. These vary in size, the largest being visible to the naked eye as individual dots. A chromatophore consists of a much-branched cell containing pigment and having one or more nuclei. A chromatophore may contain one or more pigments, and these may be present in solution or as granules, according to their chemical composition. The peculiarity of the chromatophore lies in the fact that the pigment may be aggregated at its centre, when it is barely visible, or may stream in a conspicuous manner through its branches. The aggregated condition is termed "contraction," its reverse "expansion," of the chromatophore. When the many hundreds of chromatophores present in the body expand or contract, the total effect is considerable.

The exact nature of this complex chromatophore is still a matter for discussion. Some regard it as an amoeboid cell, expanding and withdrawing its processes into spaces among the surrounding cells, and certainly young chromatophores are formed deep within the

body and migrate in amoeboid fashion to their adult position. But the very complex branching of the adult chromatophore makes this conception of its working a matter of difficulty. Recently consecutive photographs have been taken of the same chromatophore in expanded and contracted phases, and these show that the chromatophore each time it expands takes the same form in minutest detail. Walls of the branches when empty of pigment have also been described. It is almost certain, then, that the pigment moves to and fro in preformed channels. If the chromatophore is not in its nature an amoeboid cell, what is it? Possibly a much modified form of muscle cell, as has been shown by Spaeth to be the case for the chromatophores of fishes. The question must still, however, remain open, though facts recently collected point in that direction.

In the *Palaemon* type (Fig. 1), red and yellow light-transmitting pigments prevail, together with a small amount of an opaque, reflecting, pale-yellow pigment, which I shall refer to as "sulphur." At night, or on transference to a light background from a dark one, a bright blue pigment is formed around the red chromatophores. This permeates the tissues like a dye, and remains for about two hours, after which it gradually fades away.

A True Colour-Sense.

In *Crangon*, the prevalent pigments are melanin and sulphur, red and yellow being present in small quantities. In passing, it is of interest to note that Koller has recently shown that this shrimp possesses a true colour-sense. It can adapt itself not only to a white or black, but also to a red, yellow or orange background. How do we know that the animal does perceive red and yellow as colours, and not merely as different shades of grey, as is probably the case in many animals? To test this, specimens were placed in succession on backgrounds varying from white through twelve shades of grey to black, but the adaptations produced as a result were quite different to those produced in response to the red, orange, or yellow backgrounds.

When the animal is adapting itself to a new background, the different pigments do not move with the same rapidity, melanin and sulphur being more sensitive than red and yellow. Neither do they all move in the same manner. It is curious that in the *Palaemon* type, for instance, red and yellow will expand on a dark background, while sulphur will contract. On a light background the reverse takes place with the additional formation of the transitory blue. How long does it take a prawn to conform to a new background? The time and the completeness of the adaptation vary with the individual, but if one is watching the process the change becomes obvious in from three to five minutes, and will be outwardly complete within half an hour. Up to two hours is needed for the change to be perfect in every detail, and if the animal is trying to adapt itself to an abnormal background, such as red, several days may be needed, as was the case for *Hippolyte*.

Elaborate Mechanism.

By what mechanism does change of background stimulate the chromatophores to movement? The stimulus from the background is received solely through the *eyes*, direct light having no influence whatever. If one eye is covered or removed, the other is sufficient to allow normal adaptation to go on. But if both are put out of action no response is observed. The stimulus, then, is received by the eye. How is it carried to the chromatophores? It was naturally supposed that a nerve supply ran from the central nervous system to the chromatophores, by which route stimuli could pass directly from eye to chromatophores. Several workers, from Pouchet (1876) onwards, tried to demonstrate that this was the case. The nerve supply to some area would be cut to see whether that area failed to undergo colour-change. But in no case, even by cutting the main nerve chain could the colour-change be affected! This seemed a remarkable state of affairs, the more so as it was already known that in fishes, cuttlefish, and certain reptiles, the chromatophores were directly under nervous control. Our knowledge remained in this condition until quite recently, when two independent workers, Koller (Germany) and Perkins (U.S.A.), began to reinvestigate the matter.

An alternative solution was suggested to Koller by a curious incident: of two yellow adapted *Crangons* living in the same vessel, one died and was partly eaten by the other during the night. The survivor was very much more yellow as the result. Clearly some substance making greater yellow adaptation possible had been taken in as food, had survived digestion, and had influenced the chromatophores. This at once suggested the presence of a hormone. With the exception of certain cells in the nerve cord of the leech which secrete a substance similar to, if not identical with, adrenalin, and occasional other obscure instances, hormones were thought to be present in Vertebrates only. (As is well known, a hormone is a chemical substance formed by an endocrine gland and passed into the blood stream, by which channel it reaches and affects structures distant from the gland.

Adrenalin, for instance, when liberated into the blood stream accelerates the heart beat and contracts the arterioles amongst other perceptable phenomena.)

Other experiments supported the idea that a hormone was present. If blood was withdrawn from a dark-adapted *Crangon* and injected into a white-adapted specimen, dark adaptation would quickly set in and would last for some time, passing off gradually as the foreign substance was eliminated. The reverse condition held good, showing clearly that the chromatophores were controlled by a substance circulating in the blood—one substance causing dark, the other light adaptation, the two apparently acting in antagonism.

Perkins showed the same fact by means of a neat experiment: he worked on *Palaemonetes*, a prawn in which the whole arterial supply to the abdomen flows along a single vessel. As ligaturing this vessel proved too difficult, he made a V-shaped cut in the side of the shell, just beside the vessel. This was then gently drawn out over the shell flap, being sufficiently constricted in this way as to prevent blood from flowing past the constriction. If a dark prawn with the abdomenal artery occluded in this way (at the front end of the abdomen) were placed on a white background, then the front part of the animal, by the formation of the white-adapted hormone, would become pale. The abdomen would, however, remain dark, since the hormone could not reach it by way of the blood stream. When the artery was released the hormone was carried to the abdomen, the chromatophores of which quickly responded.

The discovery that hormones were present in Crustacea was a striking one; they had been considered as the exclusive property of the Vertebrata.

It follows that it was necessary to discover the position in the prawn of the endocrine glands responsible for manufacturing these hormones. Tissue from every part of the body was crushed in sea water and injected to see whether it would influence the chromatophores, but for a long time in vain. The query then arose, if the eye receives the stimulus is the hormone made immediately behind the eye, in its stalk? An extract made from eye-stalks was injected with startling results. *Complete light adaptation* took place in dark prawns, no effect being produced in light ones. The eye-stalks, then (Fig. 2), are the seat of the white-adapting hormone which will be referred to hereafter by Koller's term "contractin." The part of the stalk responsible for this is still unknown, for it contains little beside the optic nerve, but this "little" may be an instance of *multum in parvo*. A certain amount of contractin seems to be present in the stalk always, but its amount is greatly increased while white adaptation is in progress and while an animal remains on a white background. It would appear that a constant output of contractin

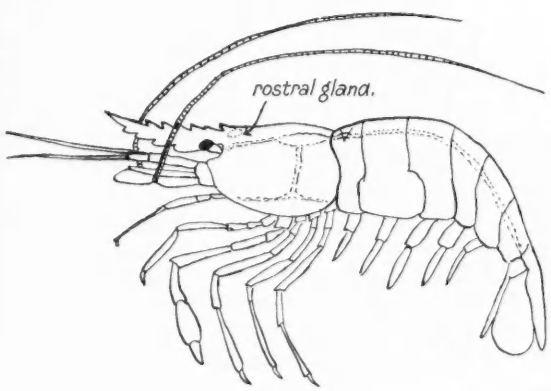


FIG. 2.
DIAGRAM OF A PRAWN.
This shows the position of the endocrine glands and occlusion of abdominal artery.

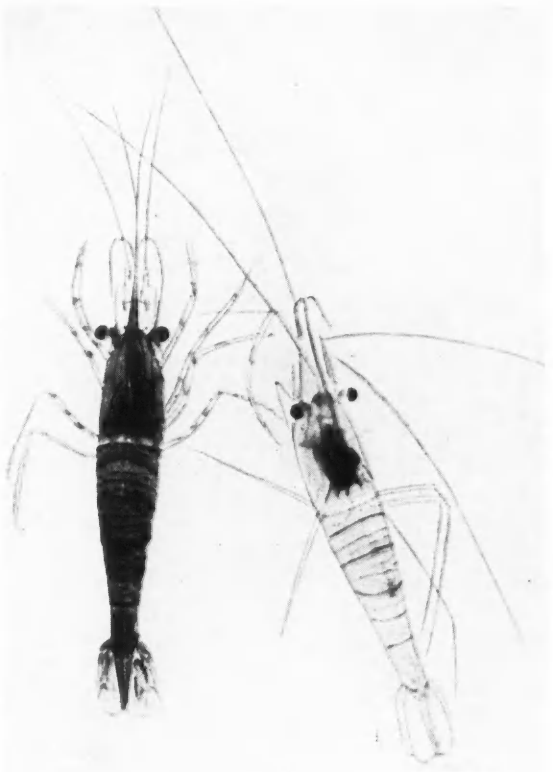


FIG. 3.
LIGHT AND DARK-ADAPTED PALAEMON.
This remarkable photograph shows the same species of shrimp adapted on the one hand to a dark background, and on the other to light.

is necessary to maintain the white condition, since if the stalked eyes are removed, expansion of all chromatophores quickly follows and white adaptation is impossible for the rest of the animal's life.

Many Problems.

Contractin, named by Koller, was discovered by Perkins, but he was unable to locate the gland giving rise to the second hormone. This was discovered by Koller, and is a small body in the rostral region, *i.e.*, it is located at the base of the spine which projects from the head. An extract made from this gland causes normal dark adaptation when injected into a light-adapted prawn. Koller terms this hormone *expantin*. If the gland which forms expantin is removed the animal becomes pale, and remains so indefinitely. So much is known, but the position is by no means simple. How is it, for instance, that contractin closes red and yellow while it expands the sulphur chromatophores? Again, is yet another hormone or pair of hormones responsible for yellow and red adaptation? What happens to one hormone when another comes into action?

The question arises as to whether crustacean hormones are similar in physical properties to those of the Vertebrata. Three general properties hold good for Vertebrate hormones—they are thermostable, they are unaltered by digestion and their action is not specific to the animal which produces them. Thyroxin from the sheep is active, for instance, in frog and in man as well. These same properties hold good for Crustacean hormones. Contractin from *Crangon*, for instance, is known to be effective in at least five other types of prawns, the extent of the reaction varying with the species, and both other properties are manifested. Experimental work so far goes to show that the hormones of Vertebrates have no action on colour-change in Crustacea, and *vice versa*.

When an important physiological activity of this nature is discovered in one group of animals, one begins to enquire into its presence in nearly-related groups, such as those containing lobsters and crabs. Strangely enough, contractin and expantin are strongly present in the shore crab, *Carcinus maenas*, as I discovered a short time ago; one does not on casual observation suspect this animal of exhibiting colour-change. The hormones of the crab are, moreover, very active when introduced into the prawn. The accompanying photograph (Fig. 3), shows a normal dark-adapted prawn and a similar prawn after injection with crab contractin.

The crab possesses these hormones, but they do not seem to exert such a strong influence on its chromatophores as in the cases we have already described, neither does movement of the chromatophores cause such an obvious change by reason of the thicker shell of the crab. If a number of shore crabs are looked at carefully, a fairly uniform pattern of dark and light areas can be observed on the back. This is caused partly by pigment in the shell itself, partly, as in prawns, by chromatophores in the underlying skin. These are to some extent visible, for the shell is actually translucent. The skin chromatophores are much like those of *Crangon*, but smaller and more densely grouped. Their movement is only visible in those areas not occupied by the shell pattern itself, this pattern being mainly dark. In a dark-adapted crab the movable areas are dark and the whole back consequently rather dark; in a light-adapted crab the movable areas are pale, so that the back shows contrasting dark and pale areas.

It is simple and interesting to witness these changes if one is at a part of the coast where shrimps and crabs are to be found. To furnish a light and dark background the animals should be placed in vessels with floor and walls of black and white. If the sea water be aerated frequently by means of a syringe the animals will live easily from morning until evening, giving enough time to watch the change in prawns at least. Those of crabs may be more difficult to demonstrate, but can be seen by careful observation.

More Research Wanted.

Colour-change is known to occur, then, in the prawn and crab types, and it has just been shown by an American worker that river crayfish also exhibit the same capacity. It would appear that the phenomenon is of widespread occurrence among the higher Crustacea, and it remains to discover in how many the capacity manifests itself and in how many, where not manifest, it is present in a latent condition.

In summarizing the position we see that in some animals the chromatophores are directly under nervous control; in others the nervous system stimulates endocrine glands to the secretion of hormones, which in turn control the chromatophores. An illuminating suggestion was recently put forward by an American professor—a suggestion which unifies the two conditions. In cases where nerves run directly to chromatophores, do they stimulate the latter by means by a secretion formed at the point of contact? Instances are now definitely known of secretory activity on the part of the nervous system itself, so that there is no reason against this suggestion. It is a matter which awaits proof but opens up a new field of enquiry of immense interest.

The Seismograph as an Explorer.

By R. E. Lancaster-Johnson.

Geological Survey, Mexico.

Among the latest applications of science to industry is the use of the seismograph as a means of locating oil. The author has been working with an oil company in Mexico, and gives a first-hand account of this method.

To most people the seismograph is merely known as a means of registering earthquakes. They regard it as an obscure instrument, standing in a laboratory and looked at occasionally by a professor of science who reports, for instance, that tremors felt in the South of England were traced to some internal volcanic eruption in Spain. Actually the seismograph has an interesting history. During the war, for instance, it was extensively used by the Germans to locate enemy artillery in registering the range by sound and earth vibrations as they fired. Its war service ended, the instrument became an explorer, and can now be found in Russia, Persia, Mongolia, Brazil and Mexico, in the constant service of oil and mining companies.

A New Venture.

It is not, in fact, generally recognized that the seismograph has recently acquired great industrial importance as a means of locating oil. The application of the instrument to industrial activities is, of course, quite a new venture. "Until recently," writes Mr. J. W. Williamson in his book "In a Persian Oil Field," "the science of seismology has been confined, for the most part, to recording and measuring the earth tremors caused by earthquakes and to deducing from the measurements the locations of the original disturbances. The seismic method of exploration is similar in principle to the other methods, in so far as it is based on the existence of a difference in certain physical characteristics between the rock-forming structure to be located and the structures above it which form the overburden. In this particular method, advantage is taken of the different velocities with which the earth-tremors—which to the physicist are elastic waves—are transmitted through rocks having different elastic properties and densities. For example, the velocities of compressional waves in sedimentary rocks are of the order of one and a quarter miles per second, whereas in igneous rocks they are from three and a third to five miles per second."

In El Zapotal, which comprises three native huts and two portable tent-houses, and situated near the village of Piedras Negras in the State of Veracruz, dwell seven Europeans and two American citizens. This little band of men is the seismos party (the only one in Mexico) of one of the leading oil companies in the country, and their business is to find the location of oil with the aid of the seismograph. The party consists of the party-manager, the engineer, the radioman, the dynamiter and five observers.

The "Shot-point."

Before a camp is pitched, the engineer is sent out to the locality in which the party will operate. Engaging fifty or sixty peons (labouring peasant Indians), he cuts a "brecha" ten to fourteen miles long through forest, scrub, and long grass. The pathway must be in a dead straight line, so that it often runs through sugar and banana plantations, mosquito-infested swamps, and clumps of shrubbery where tarantulas, scorpions, and such parasites as the garrapato and pinalia abound. When the brecha has been cut, numbered stakes are placed in the cutting at calculated distances about six hundred metres apart, indicating the positions where "observing stations" will operate, and holes of nine feet deep and twelve inches in diameter are drilled for the "shot-point." On completion of the first brecha, the rest of the party arrive and the "shooting" begins on this cutting, while the engineer carries on with the second cutting, which generally runs through the centre and at right angles to number one. So he continues until the brechas run from the camp like the spokes of a wheel from the hub. He works from sunrise to sunset, and is often so far away from camp at night that he has to build a smoky fire around him so as not to be literally stung to death by the millions of mosquitoes that exist in the swamps.

It is of the actual operating of the instruments themselves, however, that I can speak with more authority, since I was both radio-shotpoint-man and observer in turn. Just before dawn two "camións" (light motor truck), loaded with instrument boxes and carrying some fifteen peons each, set out from El Zapotal. The observers and the radioman and their assistants, a company of twelve in all, follow the

motor trucks on horseback. A fork in the road is reached, and the "shot-point camión" turns to the left, followed by a European horseman and his Mexican "audante" (assistant), while the other car and the mounted men proceed down the straight. Soon the road which the trucks have taken become little more than a sheep track, and eventually the motors must make their way over rough ground, through tall grass, winding in and out of wood and copse. After a two hours' journey the edge of a swamp is reached, when the dynamite and radio instruments have to be carried round to the entrance of the brecha near the point at which the first shot will take place.

EL ZAPOTAL.
The camp of the Seismos party comprised three native huts and two portable tent-houses. The author occupied the circular hut in the centre, which was made of grass.

Under the direction of the dynamiter, who has ridden in the truck, the explosive is carried (each peon packing one case of twenty-four pounds) to the "shooting point" where the sticks are taken out of the boxes, and the already drilled holes are filled. The dynamiter then "tamps" it down, inserts the fulmanite caps and attaches the shooting line, run out from the point at which the portable wireless transmitter and receiver has been erected to a point some seven hundred metres away. He then returns and takes up his position near the wireless instrument to wait until he receives the "all ready" sign from the radioman, before he finally connects up his line completely for "shot." While these shooting preparations are in progress the radioman has had his aerial poles erected, and his radio instrument set up and adjusted for work. The radioman then depresses a key which starts a powerful buzzer working, and the signal is picked up by observers. This allows them to adjust their seismograph, oscillograph and camera ready for the shot. For three minutes the radioman depresses his key, then he switches over and speaks into the microphone asking if any stations are ready for shot.

The other camión and riders, who left the trucks at the fork of the road, have had a similar, though less dangerous journey. They are not carrying dynamite, but only the instruments required for the recording of the shot, the small tents and batteries. The truck may sink axle deep in soft ground, and it requires the combined efforts of all the peons and the saddle horses to get it on to firm ground again, but they eventually arrive at an entrance into the brecha approximately midway between the points at which they have to operate. The truck is unloaded, and the instruments in their trunk-like boxes are carried to their respective stations. Meanwhile the observer, who in all probability will be the last man to be ready for shot, rides slowly down the brecha, followed by his quadrilla (section of five or six men) with the apparatus on their backs, each man carrying something like eighty to one hundred and ten pounds. Eventually, he comes to a rough hewn stake stuck in the middle of the cutting, and on this stake is a number corresponding with the number given to him in camp as being the point at which he will take his first "shot."

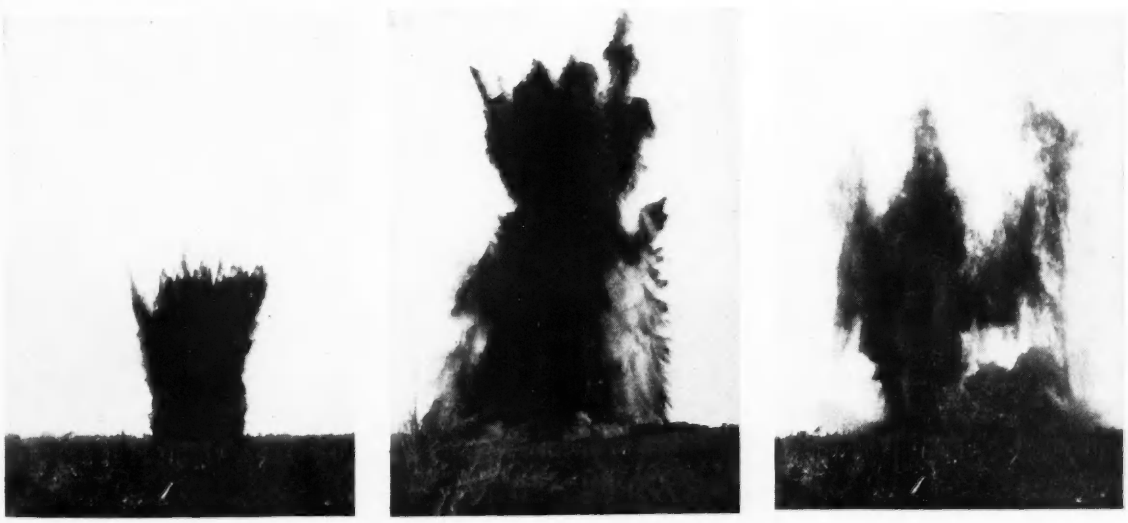
There the men begin to erect a station. The red-lined tent is set up, and along one wall is placed the compact wireless transmitter and receiver with its heavy high-tension batteries and large twelve volt accumulator, the latter being used for the camera light as well as for the wireless set. At the back of the tent the observer carefully places the seismograph and oscillograph facing the tent door. Then the heavy clockwork camera is set up on its tripod, the lens facing the seismograph and oscillograph some three feet from these instruments. The tent door is now closed, and the observer is in darkness. He switches on the hooded spot-light which is part of, and just below, the lens of the camera, its beam encircling both heads of the two instruments opposite.

The portable seismograph is similar in appearance to a four-sided clock tower, and is about three feet in height. A steel casing contains two suspended cones so delicately balanced that even the tapping of the ground with one's finger near the instrument will oscillate the two small mirrors that are attached to them by means of a human hair at the top or point of the cone. One mirror oscillates to vertical vibrations in the earth and the other to horizontal vibrations.

The vertical mirror only is considered necessary in locating oil, and the other cone is clamped up, but can be used in case of emergency. At the head of the seismograph, and in front, is a circular window about two inches in diameter through which the two small vertical mirrors can be seen. At the back are two adjusting screws for each mirror, which operate them in a vertical or horizontal position. When the beam of light from the camera strikes these mirrors, a " spot," or reflection, is thrown towards the camera, and by the aid of the adjusting screws, these spots can be manoeuvred so as to shine directly into the camera.

The observer, sitting on one of the instrument boxes in front of his apparatus, manipulates these screws, until the spot is shining directly into the lens. This is a tedious piece of work for the beginner, as the mirrors are only about three-eighths by a quarter of an inch in size, and the spot, as can be well imagined, is very difficult to find. Once found, however, it is an easy matter to bring it into the lens. After adjusting the seismograph spot, the observer turns his attention to the oscillograph directly by its side. The oscillograph is nothing more than a telephone receiver with a small vertical mirror (similar to those in the seismograph) attached to its diaphragm, and enclosed in a metal case mounted on an adjustable tripod. Two wires run from the oscillograph to the receiver of the radio set, so it can be readily understood that strong incoming signals actuating the diaphragm would in turn cause the mirror to oscillate. This instrument also has a small circular window in the casing through which the mirror can be seen. This mirror, like those of the seismograph, is focussed on to the lens of the camera by adjusting screws, and when both spots are " on," the observer calls for light, while he examines his camera to see if there is sufficient sensitized paper on the " roll," and whether the clockwork, which carries it behind the lens, is working smoothly. The smooth working of the camera is very important, for the seismograph is so sensitive that the slightest vibration near the camera will cause the mirrors to oscillate, and should the mirror be oscillating when the shot is fired, the shock vibrations or " kick " coming in from the explosion will be lost on the photographed record, rendering the record useless.

His spots set, and the radio and camera working well, the observer slips on head-phones, tunes in to the " control station," and soon hears the low hum of the powerful buzzer as the radioman at the shot-point sends out his testing signals. Signals are sent out every fifteen minutes, and are followed by a request for the observers to report when ready for shot. Tuning in the signals to maximum, the observer switches over to the oscillograph and looks into the lens of the camera to see the oscillograph spot spread out to a vibrating line of about one-half inch as the incoming signals actuate the diaphragm. This is satisfactory, and if the seismograph spot remains steady, it indicates no outside disturbance and only moves if the " observer " taps the ground with his



THREE VIEWS OF AN EXPLOSION IN PROGRESS.

These photographs of an actual " shot " were taken from a distance of about six hundred metres. Left to right they show (1) the start of the explosion; (2) its full height; (3) settling down after the " shot."

foot. After three minutes of testing the buzzer stops. The radioman asks if everyone is " O.K. and ready for shot." All stations are ready by now and give their O.K.'s in turn. The radioman gives the warning, and the dynamiter connects his line to the " shooting box " via the radio instrument, so that when he drives the plunger down to fire the charge, the buzzer circuit is broken and the signals are immediately cut off. When the line is fixed, the radioman depresses his key and commences to send a series of long dashes.

The Explosion.

As soon as the first long signal comes through, the observer calls to his audante for darkness, the tent is then closed, and the head man of the quadrilla sees to it that none of the waiting peons so much as moves for the next three minutes. In the stifling tent, where often dozens of mosquitoes have collected, the observer switches on the camera spot-light, changes over the incoming signals from head-phones to oscillograph, and peers into his lens to see the stationary spot of the seismograph and the vibrating line of the oscillograph. For two minutes the long signals come through to give the operator time to get fine adjustments of his spots. Then comes the third and last minute of the warning. This is followed by short signals for half a minute, silence for fifteen seconds, short signals again for five seconds, and then the radioman calls out to the dynamiter to stand by. The dynamiter pulls up the plunger of his " shoot box." For the last five seconds the radioman holds down his key so that one long continual buzzer signal is sent out. Then he instructs the dynamiter to shoot. The plunger is pressed and the buzzer signals are cut off by the action of the explosive cap connecting the radio. Seven hundred metres away trees and boulders are blown to a height of two hundred feet by the explosion of two hundred and eighty pounds of dynamite.

When the observer in his tent sees the oscillograph change from a steady vibrating to a spasmodic jerking for the second time, he knows it is only ten seconds from " shot." He immediately starts his camera and peers again into the lens. The jerking of the oscillograph " spot " breaks once more into a steady line and the observer now keeps dead still, even holding his breath for the last few seconds. Suddenly the oscillograph ceases to vibrate and becomes still; probably two or three seconds elapse before the seismograph " spot " " kicks " a few times and then remains steady. If the observer were to let his camera run a few seconds more, the seismos " spot " would oscillate again, this time more violently as the sound vibrations of the explosion struck the instrument. But the expert observer stops his camera before this takes place, as a record of the sound vibrations are not required.

Quickly switching off the " spot-light," he slips on the head-phones, takes out the portion of unrolled " film " from his camera, and develops and fixes it in the chemicals (already prepared beforehand by his audante). The record fixed, he calls for light, and his audante opens up the tent and produces water with which to wash the record. By the time the film is washed, the aerial poles are down, the tent rolled up, and half the instruments are packed. Ten minutes after the firing of the shot the station is packed up and the party is ready to move on for the next shot.

In flat country, and where conditions are favourable, four or five " shots " a day can be made. But in the rainy season sometimes only one " shot " can be obtained owing to the difficulty of transporting the instruments over the swampy district of the isthmus. In the " Norther " season, when strong winds blow, it is impossible to make a " shot "; for wind-blown trees and shrubs and the swaying canvas of the tent will cause disturbance in the seismograph and render a good record impossible. In spite of its sensitiveness to movement, however, the seismograph system has the advantage over others at present in existence that a considerably larger area is covered in a much shorter time.

The records obtained are sent to the head office, where a seismos calculator ascertains, from a study of the records and by calculation, the different stratas of the earth, and whether liquid is present in the particular area surveyed.

" Buchan Spells."

ACCORDING to Dr. C. E. P. Brooks, no scientific value whatever attaches to the so-called " Buchan Spells " cited by the newspaper weather prophets. The late Dr. A. Buchan enumerated six cold and three warm spells which recurred about the same dates each year in Scotland in the 'sixties of the last century. To discover whether similar periods occurred in London, observations have been made at Kew for more than thirty years past. The results do not give the slightest support to the idea that there is any abiding tendency for any part of the year to be either cold or warm for the season. The famous " Buchan cold spells " are abnormally warm as often as they are abnormally cold.

A Medical View of Good and Evil.

By R. McNair Wilson.

Author of "The Beloved Physician."

On the basis of conversations with the late Sir James Mackenzie, the author gives for the first time the views of this distinguished physician on what is one of the oldest problems in the world. The "doctrine of reaction" has special interest as being based on so many years of practical experience.

At the time of his death, the late Sir James Mackenzie, whose early work has, by common consent, revolutionized the knowledge of heart disease, was engaged on a series of speculations which he was not able to carry further than their preliminary stage. These speculations aroused a great deal of controversy, when some inkling of their nature reached the ears of the medical profession, but the material of sustained argument and criticism was lacking. To-day Mackenzie's latest ideas are largely unknown, even to members of his own profession. The present author was privileged to enjoy many opportunities of hearing Mackenzie expound his views, and thus came to be possessed of a body of notes, for he kept a record of what he had heard, the interest of which is very great. A study of these has suggested that the great physician was in process of evolving what amounts to a new philosophy of medicine when death overtook him. It has suggested, further, that an account of these ideas might be of general interest.

But it is necessary to explain, at the outset, that the views expressed have undergone a prolonged period of evolution in the mind of the present writer. They are not, therefore, put forward as representing exactly what Mackenzie thought, but rather as representing an effect of Mackenzie's later thought, teaching, and experience. It may be that an important difference lies in this distinction. On the other hand, an implanted idea, while it may assume different shapes in different minds, is likely to develop along the same lines, more or less, in any mind since its vitality lies in itself.

The Nature of Life.

Mackenzie, in his last days, found himself face to face with the oldest problem in medicine, namely the nature of life itself. He had worked towards a point from which he obtained a glimpse of a country not hitherto explored by any of his comtemporaries or predecessors, and he used to call that country "reaction." The word is, of course, a commonplace of thought and discussion, but in Mackenzie's mouth it had a special and peculiar significance which can best be grasped by saying bluntly that he was asking himself *if all stimuli are lethal in their first effect on the living organism.*

Constant Struggle ?

In other words, are those agreeable forms of energy with which our lives are habitually surrounded, light and sound, deadly weapons, the blows of which we only succeed in parrying by the exercise of vital activity? Put in this way the question seems absurd enough, but, in fact, a large body of evidence exists in support of an affirmative answer. Everybody is well aware that a strong stimulus often causes death, for example, a loud sound, a blazing flash of light, or a blow. In each case a condition of shock is produced and what Mackenzie meant by reaction does not take place. It is not, however, absolutely necessary to a fatal issue that the stimulus should be strong, and this point must be emphasized. A whispered word may kill. So may a gleam of light in certain special circumstances. So again may the touch of a finger. For these trifling stimuli may be "associated" with memory images that are far from trifling and which at once augment the effect, for example, when a guilty man feels the policeman's hand on his shoulder.

Again, there are states of physical weakness in which to pull up the blind of the sick-room is to cause the patient to faint, in which any loud sound, or any sound at all, may produce collapse, in which the very weight of the bedclothes becomes an impossible burden.

The enfeebled patient, in Mackenzie's view, is a patient with a greatly reduced power of reaction, and therefore a patient incapable of resisting the slings and arrows of his environment. He lies at the mercy of the lethal stimuli which surround us all. The sunlight, music, the gentlest physical contacts, even these are so many deadly dangers. This conception led at once to the question: what is the power of reaction, and how is it manifested? A direct answer was soon seen to be impossible, as

is generally the case in medicine. For the power of reaction is not to be measured as a potentiality. Only when it is manifested can it be measured. *Until a living organism is stimulated it cannot react at all.* Though, therefore, stimuli are lethal in the sense that they kill if no reaction takes place, they are also essential to life since no reaction can occur in their absence, a lively paradox, which, as Mackenzie saw, underlies every phenomenon of life, whether physical, mental, or spiritual. That paradox, as he used to say, haunts the mind of the philosopher who is troubled to understand why a God of infinite power and goodness tolerates evil, and how, as is evident, temptation is necessary to the building of moral strength. "It is by taking blows that we grow in fitness; it is by resisting temptation that we grow in grace."

The body is supplied with an elaborate system of nerves whereby stimuli are transmitted to all its members. This system, consequently, ensures that the lethal influences of environment shall penetrate to each cell. Reaction, therefore, is in the cell itself. It is, again, in every organ because it is in every cell of every organ. The first effect of a strong stimulus or shock is to cause the heart to stand still; its last effect, if the heart is sound, is to cause increased vigour of beating. But the word "cause" must be used with full understanding of its meaning. The stimulus never, in fact, *causes* reaction; it merely challenges it. There may be no reaction; for the stimulus may kill. There may be a feeble and ineffective reaction, as for example when the stimulus brings about a partial collapse. There may be a powerful reaction, as when the athlete returns blow for blow and overwhelms his opponent.

But again, reaction will vary in the same person at different periods of the same day. It will tend to be most effective in the morning; least effective at night. It is an exhaustible power as well as a power capable of cultivation and restoration.

"Nerves."

Everyone knows that stimuli are of all sorts of degrees and kinds. There is bright light and dim light; there is loud sound and soft sound; there are severe and gentle contacts. But what is less clearly realized is that the same stimulus may be severe in one case and gentle in another. A pat on the uninjured skin is a gentle stimulus; the same pat, on a raw wound, is a stimulus of excessive severity. The possessor of a raw wound cannot endure ordinary stimuli on the raw area, not because his power of reaction is diminished, but because his power of receiving stimuli is enormously increased. It is only necessary to suppose a case in which all the special senses are unduly acute to have a picture of a person incapable of living in his world. That many such people exist is certain. They are the nervous wrecks whose disabilities are too often ascribed to such causes as "hysteria." In fact, they need careful examination at the hands of specially trained physicians.

Failure to React.

Again, a stimulus received on a normal area of the skin or by a normal organ of sight or hearing may be exaggerated, in its passage, by nerves which are unduly sensitive. This occurs in strychnine poisoning, when the lightest touch is so violent a stimulus that the whole body is thrown into a convulsion in attempting to react to it—the convulsion representing a supreme effort to respond. It occurs also in diseases which excite the nerves. Mackenzie saw in all these considerations evidence that many of the symptoms of disease are, in fact, signs of failure to react to stimuli. Further, he came to think that such failure arises much more often as a result of exaggeration of the stimulus than as a result of any change in the power of reaction itself. For example, most cases with symptoms apparently referable to the heart are, in fact, cases in which the stimuli reaching the heart have been exaggerated by passage over an irritable nervous system, or by reception upon special senses made excessively sensitive by injury, deformity, or disease. He himself cured a case of chronic dyspepsia by getting the victim to wear spectacles and so removing the irritation to the whole nervous system caused by an astigmatism. The dyspepsia was a sign of that general irration and the consequent failure to make responses to the calls of life. Stimuli being lethal, it follows that exaggeration of stimuli imposes a heavy additional burden on the responsive mechanism and so leads quickly to symptoms of failure of response.

It is here that the mental process impinges on the physical. Man's mind is so constituted that almost every stimulus discovers associations in memory images which are, in fact, stored up stimuli. Thus, a voice recalls its possessor and the memories connected with him and all these are at once added to the simple stimulus of sound, with, it may be, devastating effect. The mind, therefore, is well able to exert an effect similar to that exerted by a poison which irritates the nerves, by an injury to a sense organ (*e.g.*, a raw area of skin), or by an actual increase in the force of the stimulus itself. A shout is a violent stimulus; so is a whisper falling on an unduly sensitive ear

or on an excited brain, so, again, is a whisper which recalls some terrible experience. In each of these cases an excessive reaction is demanded, exhaustion follows, or the patient does not even react with enough vigour to prevent the lethal effect of the stimulus from being revealed in collapse, perhaps in death.

Mackenzie's interest was directed, therefore, towards the factors augumenting the strength of stimuli, rather than towards the responses to these stimuli. He began to study sensitization and desensitization (It is known, for example, that a dose of haematoporphoryn, a well-known drug, may render an animal so highly sensitive to light that exposure to sunlight will kill it.) Both of these processes may be purely physical or purely mental, or a combination of physical and mental. For example, we may sensitize nerves with strychnine or desensitize them with bromide; we may sensitize the mind with alarming or terrifying suggestions, or desensitize it with confidence and security, and we may combine the use of drugs with suitable encouragement. The effect will be either to augment or diminish the force of stimuli, and hence the degree of response to them.

Out of all this emerged a philosophy. Reference has already been made to the toleration of evil; Mackenzie, perhaps, would have preferred to speak of the necessity of evil as a means of evoking good. He saw, too, that the good so evoked became stored up in memory as a " desensitizer " of the moral nature towards the very evil which evoked it. A man who has resisted temptation has forged, in his resistance, a new weapon against its future assaults. He is less temptable. Again, there are unseen sources of courage and confidence which discount the strength of temptation, just as there are sources of weakness and fear which augment it. The spirit of man may thus achieve complete victory over those powers of evil which threaten it with death, and in that sense may overcome death.

Moral Power.

The physical power of reaction necessarily diminishes and ends; but the moral power of reaction is not thus limited. The threat of physical death, which can destroy *morale*, can also evoke its most excellent expression, so that martyr and patriot seem to transmute the very act of dying into the substance of immortality.

Paradox and mystery surround this remote end of Mackenzie's thought. But his vision loses nothing of its interest on that account. He saw the office of the physician from a point of view far removed from that of the mere student of disease.

Correspondence.

EMBRYOLOGY AND EVOLUTION.

To the Editor of DISCOVERY.

SIR,

In another review by Professor MacBride of this very same book of mine, " Embryology and Evolution " (*Discovery*, June), he showed that he had either read or understood so little of it that he charged me with making statements which I never had made and which were not in the book at all, and with omitting matters which were printed in my book in terms almost identical with those in which Professor MacBride deplored their absence. These, and kindred matters, are set out in detail in the current number of the *Eugenics Review* (Vol. XXII, pp. 71-74). I am glad to see that on this occasion he has abandoned these charges, though he still maintains that my book is full of fallacies which " would require a long and elaborate essay to expose them in detail."

I would like to draw attention to what I consider to be a fundamental fallacy on the part of Professor MacBride. He says that he believes in the " doctrine " of Recapitulation because hermit crabs, when young, have straight tails, and because in general the young forms of aberrant members of a group of animals conform to a type. By what logical right does Professor MacBride assume and assert that this common youthful type must represent an *adult* ancestral type? I defy him to prove it.

Yours faithfully,

4, Holywell, Oxford. G. R. DE BEER.

" THE TRUTH ABOUT PERSPECTIVE? "

To the Editor of DISCOVERY.

SIR,

I do not doubt the correctness of Mr. Boxsius's explanation (June) of the results of my experiments as due to the knowledge of the actual dimensions of the seen objects. It is the explanation that I myself gave. I disagree, however, with his consequent dismissal of the results as examples of " errors " in perception. This use of the word " error " implies a false theory of perception. Mr. Boxsius seems to suppose that our perceptions ought to be in photographic perspective although, in fact, they are not. No perception in itself can be called " erroneous or unsound." Such a judgment implies reference to a standard. If we did perceive in mathematical perspective, such perception would be erroneous when judged by the standard of the physical shapes of objects. If we perceived them in their physical shapes, it would be erroneous when judged by the standard of mathematical perspective. Actually we perceive objects in a manner which is a compromise between these two ways. If we draw in mathematical perspective (and there may be better reasons for doing so than the trivial one that other ways of drawing appear to us to be " primitive or exotic "), then let us at least be clear as to what we are doing—we are not drawing things as we see them but in another (perhaps better) manner. Then we shall cease to talk about the " erroneous " perceptions of children, and appreciate more exactly the difficulties they have to overcome in learning to draw in the manner we require.

Our perceptions may, and often do, mislead us as to the real properties of the objects we are looking at; they cannot

mislead us as to how we perceive. Let us suppose that I ask Mr. Boxius to match an ellipse with the apparent shape of a circular disc lying at such an angle that the short axis of its perspective figure is exactly one quarter of the length of the long axis. Let us suppose that he selects an ellipse of which the short axis is only one half of the length of the long one and says that this looks to him the same shape as the apparent shape of the figure he is looking at. Then, if he is answering truthfully, that is how he *perceives* the circle, not merely how he "thinks he perceives it."

A friend in Palestine very kindly sends me the following incident from *The Life of Sir William Quiller Orchardson*. When painting his "Napoleon on board the Bellerophon," Orchardson had been persuaded to save himself trouble by getting a "perspective man" to draw in the boards of the ship. When the perspective man had done his work, Orchardson "went to his studio, looked at his picture, sent for the housemaid and demanded a scrubbing brush and a pail of water, with which he scrubbed out the day's work of the perspective man, then he drew the boards in himself easily and quickly. He told me the boards appeared to be almost standing on end when drawn according to rule because the eye does not see correctly; and a picture to be correct—right—must represent what the eye can see." Thus, by practical experience, Sir William Orchardson discovered what can also be proved by laboratory experiment—that the laws of perception differ considerably from the laws of mathematical perspective.

Yours faithfully,

The University, Glasgow. ROBERT H. THOULESS.

To the Editor of DISCOVERY.

SIR,

In your June issue Mr. R. H. Thouless uses the expression "the laws of psychological perspective." I hope he will be able to discover what these laws are, but it must not be assumed that every artist has a sort of instinctive knowledge of perspective, whether mathematical or psychological. Most painters of objects of which the perspective can be tested mathematically have had to make a careful study of the subject, and there are some quite eminent ones who have not mastered it, even among those who have specialized in architectural subjects. Others, who have devoted themselves to subjects in which the perspective is not so easily called into question—landscape, for example—have given the matter far less serious attention, and their perspective is generally more or less logical guesswork, which produces satisfactory results unless the subjects present unusual difficulties.

No test with the human eye can obtain exactly the same results as those obtained with the imaginary mathematical eye which is focussed to a point with "no parts or magnitude." But Mr. Thouless's argument, as I understand it, is that the variations from the mathematical perspective which he has noted in pictures and in experiments are greater than one has any right to expect, even when full value is given to the human factor. This is certainly a matter for the psychologist. I believe that the ordinary untrained eye frequently sees things just as loosely as the ordinary untrained brain frequently conceives them. The average person will be satisfied that there are "half a dozen or so" chairs in a room; the mathematician wishes to know that there are precisely five, six or seven. The laws governing such variations can doubtless be formulated, but I feel sure that they cannot be justified as a *substitute* for mathematical laws, in painting or anything else.

Yours faithfully,

The Priory, Orpington. C. E. HUGHES.

To the Editor of DISCOVERY.

SIR,

I have read with great interest Mr. Thouless's article "The Truth about Perspective?" (April), and Mr. Hughes's comment in your May issue. If you will allow me the space, I will advance arguments that go to prove, I think, that (1) Mr. Thouless's discovery is probably quite valid; that (2) the teaching of perspective drawing should nevertheless continue; while at the same time (3) Mr. Thouless's discovery has great value for both art critics and art teachers.

(1) The question of the validity of the discovery can be approached through a consideration of Mr. Hughes's criticisms. Mr. Hughes has very clearly demonstrated the variation between mathematical perspective, which assumes only one eye-point, and visual perspective, which is a product of vision from two eye-points. It is important to note, however, that the compromise between the two "eye-views" which we get in visual perspective, is a compromise between two views, each of which is in *mathematical perspective*; whereas the compromise which Mr. Thouless says we make in seeing shapes is one between a perspective view and a purely mental conception of the real shape of the object being looked at. Mr. Hughes's criticism therefore fails to touch Mr. Thouless's thesis.

It may appear strange to some that physical vision should be influenced by the mind to the extent suggested by Mr. Thouless; but conclusive evidence has been brought forward by modern psychology, and endorsed by teachers of philosophy, that our vision is at all times largely mental. It is believed that our vision of an orange, for example, would be vision merely of a confused round mass of dark and light yellow, were it not for our past innumerable experiences of touch and smell sensations, which by association with our visual sensations of shape and colour, enable us to interpret these last and see the orange in its actuality.

The final appeal in this matter, however, must be made to experience. My own drawing experience (a fairly lengthy one) was always that the ellipses presented by circular shapes appeared to my eye broader, or "fatter," than I found them to be by measuring with the pencil at arm's length. More convincing than any individual's testimony is the concentrated experience contained in Mr. Thouless's experiments. These, with his analysis of orthodox and "post-impressionist" pictures, are to my mind quite convincing, and accordingly I for one accept his findings as absolutely correct.

(2) The question now arises: "Should drawing in perspective continue to be taught and practised?" This cannot be answered until another question is first considered: "Is the effect of a drawing in perspective any more realistic than that of a drawing of 'seen' shapes?" If it is, then I take it almost for granted that perspective drawing ought to be maintained. The realistic representation on a flat surface of the third dimension is one of man's greatest achievements; it immeasurably widens the scope of art; and two-dimensional pattern-making by means of "seen" shapes, such as that practised by Matisse, has no proper claim to be more than a special form of art, unless it is capable of presenting to human beings as realistic effects as have been hitherto presented by

Lectures in Three Languages.

NEW SPEAKING APPARATUS IN USE AT THE WORLD POWER CONFERENCE.

Photographs from Berlin showing new apparatus for giving lectures in three languages simultaneously, as described in *Discovery* last month. On the left is the sound-proof mouthpiece used by the speaker, a similar apparatus being used by the two interpreters. The right-hand picture shows members of the audience using headphones and switch-boxes by which they can listen-in to the particular language desired.

perspective drawings. I speak of " realistic effects " presented to " human beings " advisedly, as I wish to make full allowance for the human tendency to become accustomed to conventions. After doing so, however, I still believe that a realistic effect can only be produced by a perspective drawing or painting.

Accordingly, I altogether part company from Mr. Thouless when he speaks of " conventional perspective " instead of " real perspective " or simply " perspective " ; and still more when he says that pictures of the " post-impressionist " school appear to us distorted only because we are so accustomed to pictures drawn in perspective. Perhaps we could get accustomed to " post-impressionist " pictures and come to derive aesthetic pleasure from them ; but Mr. Thouless has advanced no satisfactory reason why we should ever expect to get the illusion of reality from them, even through custom. He says that photographic exaggeration of perspective effects in near objects passes unnoticed, but that is not my personal experience. To take a practical point, the mere presence of photographs with their (on the whole) strict perspective would prevent us from regarding anything but perspective drawing as realistic.

A more fundamental question is, " What is signified by the agreement of photographs with perspective drawings ? " To my mind there is signified the inseparability of perspective representation and realistic effect. The one argument needed for this, and for the solution of the whole problem, is indicated by Mr. Thouless himself when he says : " If the illusion of distance is perfect in a picture, then the mind will make its own corrections on circular shapes just as it does in looking at a real circular object." The matter becomes clearer if that sentence is rewritten as follows : " If the perspective in a picture is strictly represented, then the mind gets a perfect illusion of distance by supplying its own correction of circular shapes just as it does in looking at a real circular object." It is surely legitimate to say this when we consider that the waking mind makes such corrections minute by minute and second by second in looking at real objects. And if this correction is already drawn in a picture (as in Fig. 4 in Mr. Thouless's article, a modern etching), then it seems only natural that, the mind making its own correction through force of habit, distortion will result from the double correction. Accordingly it seems to me quite certain that realistic effects in pictures can be built up only on a basis of strict perspective drawing.

(3) In spite of what I have said above, I consider that Mr. Thouless's discovery is one of great value. It should clear the air of art criticism, for there will no longer be any wonderment (at least on the score of perspective) as to whether " post-impressionist " or orthodox artists draw the more correctly, or as to whether there is a standard of accuracy. That standard is supplied in the realm of perspective, by strict drawing, and the " post-impressionist " school can only claim that their's is a special form of art, or a new convention in it.

Still more valuable will be the effect of the discovery on the teaching of art, for the art teacher will be able to teach perspective drawing more sympathetically, and therefore with better results, than hitherto he has been able to do. This applies specially to the teacher of young children. Instead of arguing with the child that he sees things in perspective when he does not, the teacher will agree with the child in its visual interpretations. But having done so, he will lead the child to observe how much more realistic perspective drawings are than the child's own impressionistic drawings, and so convince him of the need for drawing in perspective. No doubt the subtle distincton will be beyond children of very tender years. But the precise stage at which the attempt is to be made of pointing it out is a matter to be determined by experts.

Yours faithfully,

THOMAS M. Y. MANSON.

Lerwick, Shetland Islands.

(This correspondence is now closed.—ED., *Discovery*.)

The Greatest Hoax of Modern Times.

By V. Gordon Childe, M.A., D.Litt.

Professor of Prehistoric Archaeology, University of Edinburgh.

Now that the case against the Glozel "discoveries" has been completely proved, it will naturally be asked why were so many experts deceived? Professor Childe answers this question, showing how it came about that an international commission had to be appointed before the greatest hoax of modern times was exposed.

ALLEGED discoveries at Glozel, near Vichy, a couple of years back received publicity rarely accorded to authentic archaeological finds. For all the fuss was over a fraud. The epitaph on the incident has just been written by M. Vayson de Pradenne, who first exposed the forgeries in France.* The time is thus opportune not only to signalize the laying of the ghost, but also to consider the lessons to be learned from its emergence.

Missing Facts.

In every science there are vast gaps in our knowledge and room for all sorts of startling discoveries to fill these gaps. But in the older sciences, such as astronomy and chemistry, an expert can to a large extent define the limits of the possible and reject *a priori* fictitious discoveries; there may be new planets in the solar system, but no astronomer will give credence to one reported between the Earth and Venus. But in archaeology it must seem, at least to the layman, that even experts can be taken in by the silliest hoax: for the Glozel "discoveries" were just as plausible. How does this come about? In the first place prehistory is divided into several widely separated compartments or disciplines: Pleistocene archaeology, Oriental prehistory, European archaeology, etc. This departmentalization is still seen in the dispersal of archaeological subjects in the Cambridge tripos. Moreover, the several departments have not arisen, like physical, inorganic and organic chemistry, from the subdivision of a single science, but have been reached from different extraneous disciplines; Pleistocene archaeology is rooted in geology; Oriental prehistory in Ancient History in the literary and philological sense.

It is really only since the war that substantial progress has been made towards unifying the results of the several distinct investigations into a comprehensive and coherent system. Such a system now exists in a rudimentary form. But some older archaeologists, trained in one of the special disciplines, do not yet always fully recognize its implications, and incline to regard the standards of their own branch as decisive for the whole. To the general public, on the other hand, such divisions (which really imply profound differences in method) are unknown; an archaeologist is an archaeologist whether his speciality is mediaeval architecture, Greek coins, or the fracture of flint by lower palaeolithic man. Moreover archaeology, like natural science a century ago, is still very largely a hobby for amateurs. The generation of systematically trained prehistorians is still comparatively young. The layman has come at length to recognize the necessity for a laborious training to produce astronomers and chemists, and the authority of those who possess such. He has not yet grasped the fact that a pastrycook or a shoemaker is not *ipso facto* more competent to decide intricate problems of prehistory than of astronomy, and expects museum-directors to master the huge literature of the subject in the intervals of classifying fossils and identifying Old Masters. Belated survivals of extreme departmentalism, refusing to acknowledge its limits, and the credulity of the public (including a large section of the intelligentsia), failing to recognize any unifying body of principles based on the conclusions of the subdivisions, alone allowed the Glozel "finds" to win more than momentary local acceptance. For in the light of modern prehistory they were patently absurd.

What was Found.

The objects alleged to have been dug up on the farm near Vichy included the following entirely irreconcilable types: pebbles engraved with bad attempts at a reindeer (an animal extinct in Central France at the beginning of Holocene times), and other scratchings in the style of Old Stone Age art; ground stone axe-heads of New Stone Age type; incredibly bad vases with eyes and nose in relief like some Bronze Age pots from Troy; and "tablets" bearing signs of the Iron Age alphabets of Phoenicia and Italy! The last named objects first aroused the interest of a local schoolmaster, and were subsequently sponsored

* An excellent translation by Mr. O. G. S. Crawford appears in the June number of *Antiquity*.

by a country doctor, Morlet. Given the backward position of prehistory as a science, both can be excused for failing to recognize the impossibility of such a collocation of periods. But to what experts should the objects be referred? Morlet found a very distinguished geologist, Déperet, whose opinion would have been useful had the " deposit " been of Pleistocene age. But the objects clearly could not fit in there, and were being attributed to the still obscure " Mesolithic " which replaces the quondam " hiatus " between Old and New Stone Ages, and here a geologist might easily go astray.

Then came Reinach, a very aged and very distinguished classic and art critic of the old school, whose strength had always been literary and aesthetic rather than scientific.* Last century, when Petrie's discoveries in predynastic Egypt were unappreciated and the prediluvian civilization of Mesopotamia (lately revealed at Ur) still undreamed of, Reinach had sought the origins of higher culture in Western Europe. His " *Mirage orientale* " was a wholesome corrective to the extravagances of Pan-Babylonists, but his arguments have long ago been condemned by the facts. (While, for instance, it was not impossible chronologically to see in the rude statue-menhirs (carved stones) of South France in late Neolithic times the ancestors of Greek statuary, that is plainly impossible for the splendid sculptures of Old Kingdom Egypt.) But in Glozel Reinach found support for his exploded theories, and his endorsement of the " discoveries " was not surprising. The sponsorship of two savants, both distinguished in entirely different disciplines and with no special knowledge of the quite recently defined Mesolithic age, backed up by a few folklorists, anatomists and philologists, was, of course, sufficient for the public whose attitude to prehistory I have characterized.

No Real Deposit.

An international commission had to be appointed by the *Institut d'anthropologie* to expose a fraud which should have been condemned *a priori*. The visit of the investigators to the site will be best remembered by the discourteous attack made by Morlet on Dorothy Garrod, the representative of Britain. The Commission exposed the absurdity of the whole affair. There was no real deposit, nor had there been any regular search for such. Now three thousand choice products of prehistoric handiwork cannot be collected from shallow trenches in a field unless there are very substantial fixed remains of human activity. At the time of writing I am digging an exceptionally prolific site in Orkney which has yielded a thousand or more relics. But we have six to ten feet of solid kitchen-midden full of shells, broken bones and ash, and the remains of ten huts within a couple of acres. At Glozel there were only traces of a glass-furnace (conveniently forgotten after the first years) and three alleged tombs that seemed to the commission spurious. The commission, moreover, found the small oblique holes whereby the objects had been introduced into the soil to be disinterred in the excavator's trenches, and other evidence of disturbance of the ground. Then a technical expert, Champion of Reinach's own museum, examined the " relics," revealing, for instance, the marks of metal tools used for drilling and grinding these products attributed to an early phase of the Stone Age ! Champion's report closed the discreditable episode as far as international science was concerned. The failure of the first victims of the hoax to recant is perhaps not surprising, but only tarnishes the lustre of their services in other fields.

Who was Responsible ?

The responsibility for the hoax is not yet fixed. Morlet's good faith has been generally admitted though his arrogance and perversity, all too typical of a certain type of selfish collector who insinuates himself into archaeology in France and other countries, did much to perpetuate the fraud. Vayson de Pradenne, who was the first to denounce the forgeries in France, has worked out a strong circumstantial case against the young Fradin, grandson and employé of the peasant owner of the farm. In his " Chronologie de Glozel " Vayson showed how the several classes of forgery (" inscribed bricks," " engravings," and eventually " pottery ") succeeded one another as models, in the shape of published drawings, were shown to young Fradin by his patrons, how the technique of the fakes steadily improved, and how the " finds " conveniently responded to every expressed wish of these patrons. And the digging was mainly done by Fradin himself with only occasional visits from the doctor, so that the peasant had ample opportunity to " salt " his field in the approved manner. But this is a matter for criminal law. The real lesson is the need for greater respect for the teachings of archaeology, and perhaps that its votaries should not be too bored or too polite to expose the absurdities of charlatans who still hang about the skirts of archaeology, though they do not happily in this country find such a credulous press as across the Channel.

* His style was well illustrated by his persuasive article entitled " Why I believe in Glozel," *Discovery*, January, 1928.

A Treasure Island of the Pacific.

By Bruce Bryan.

The theory that the desert island of San Nicolas was once inhabited by a hardy race of Californian Indians has now been proved by the archaeological discoveries of a recent expedition. It is also suggested that the Indians of the Stone Age were as keenly developed as the average twentieth-century human being.

It is difficult to trace the first record of San Nicolas Island; its existence was vaguely known long before it was ever mentioned in writing. Presumably it was first visited by a band of Indian warriors in search of the seafood which abounds about its shores. Were these Indians fleeing from the tide of the rising Pueblo races, or were they seeking a new home because of dissensions and rivalry in their own cultures on the California coast? Whatever the underlying cause, the fact remains that only a hardy, aggressive race could have built up a permanent abode on the volcanic segment known as the "Passing Isle," where a howling gale is almost eternally raging and heavy seas constantly thunder down upon its rocky coast.

For years San Nicolas Island has been deserted, occasionally visited only by fishermen, since nowhere in the world do better or larger quantities of deep sea fish abound. Pirates, smugglers, and rum-runners, too, haunt its vicinity, but they rarely land. It is feared because of the curious natural phenomena of the elements that seem to have marked it for their own, and through which it has acquired an evil name. Yet as a field for archaeological research it has proved to be a veritable storehouse.

Origin of the Inhabitants.

Numerous theories have been advanced from time to time as to the origin of the Indian tribes of California, and especially those of the outlying Channel Islands. Some ethnologists have regarded them as the descendants of those prehistoric people who once inhabited most of the south-west attributed to the Cliff Dwellers and Pueblos. They believe that the later house-building aborigines drove out these people and forced them to move on to California, where some of them took refuge along the coasts, while others ventured out to the islands and set up a culture of their own. Here they established trade with other islands and with the mainland, as shown by the many relics of their ancient commerce found to-day.

Supporting this theory is the fact that the California tribes are an older racial type than the Pueblos or Cliff Dwellers. Skulls of both the coast and island Indians reveal distinct dolichocephalic types, whereas those of the more advanced inhabitants of the south-west are clearly brachycephalic, or round-headed. Further, the Pueblos indulged in the custom of early applying a cradle-board to the heads of their infants, thereby causing them to grow to maturity with a peculiarly flattened cranium in the occipital. No traces of such artificial deformities have ever been found on either the coast or islands. But many articles of trade from both areas have often been unearthed, from soapstone images to pottery fragments and burnt shards. If there was ever a meeting point of the two opposing cultures, it probably was in northern Death Valley, where Pueblo shards of the most primitive black-on-white design and earliest coiled-ware are found in typical California Indian shell-mounds.

Valuable Finds.

An expedition organized by the Los Angeles Museum of History, Science and Art recently spent two months at San Nicolas Island, and returned with one of the largest and most complete collections of prehistoric Indian remains ever assembled on one trip. Among the material brought back and now on exhibition in the Museum are great stone mortars and carved pestles, bone- and shell-ornaments, beads of intricate and delicate carving, war-axes and clubs, abalone-shell fish-hooks, and a number of fine examples of small fish images carved out of soapstone and pearl shell. Four complete skeletons were found, together with a heterogeneous collection of human and animal bones.

Several hitherto unestablished facts were proved by this expedition, among others that the ancient Indian who dwelt in the most primitive of Stone Age environments on this barren island was evidently possessed of all the physical and mental characteristics of the average twentieth-century human being! And yet each of the four complete skeletons shows some indication of disease. The most interesting of these is a large one of a native who lived to be an old man, which was discovered to have a disease of the spine contorting it entirely out of

shape, and showing that this particular creature must have been a hunchback.

Completely encircled by dense beds of kelp through which small boats must thread a precarious path, San Nicolas is a desert place where nothing grows except a few straggling weed-clumps and cactus-beds and perhaps four inches of buckthorn grass on small stretches of the uplands. The sand is always blowing, in great dunes, from place to place, uncovering one graveyard only to conceal another. Enormous quantities of it are blown into the ocean, and on one day towards the close of the expedition's stay there, the combined forces of wind and rain had caused the north shore to present a muddied belt of water extending out through the breakers for half a mile. It is because the island is gradually being blown into the sea, that it is often referred to as the " Passing Isle."

Indian Life.

The expedition's first few days were spent in exploring the island and locating various sites in which to dig. Unlike most excavations, the order of approach here was different, since there were no strata by which to be guided. The method of procedure was sometimes to work together, and more often to work singly on separate sites, thereby carrying out three separate researches at one time.

A number of evidences of Indian dwelling places were found on the highlands, those above the west end seeming much older than the others, as shown by the hard nature of the soil and the scarcity of remains. But at times a great sand mound rises up, covered in the sun with a glittering shell-heap, where here and there a bone needle, an awl, some fish-hooks, exquisitely carved, or the top of a skull might be discovered exposed to the air.

Age of the Relics.

Arriving at the ages of the various relics found is a difficult question and can only be approximate. No trace of Spanish remains of the era of the *conquistadores* was uncovered, nor is there any record of one ever having put foot on the shores of San Nicolas, though they visited every other island of the Channel Group.

It is certain that all of the objects encountered on San Nicolas are at least one hundred years old, since the last natives were removed in 1830, with the exception of the so-called " Lost Woman," who was marooned there for twenty years and was taken off in 1850 ; she could not have left many relics by herself. Nevertheless, the nature of the soil goes a long way in aiding the archaeologist to determine the approximate period at which a particularly hard formation of sandstone, which must be hacked into with the aid of a pick and which yields up a skeleton or parts of one, was soft, loose sand as on the mounds. Again, it is a matter of osteology to arrive at the age of a handful of human teeth found in a somewhat similar formation, and which are so decayed

THE COMPLETE COLLECTION.

The Los Angeles Expedition returned from San Nicolas with one of the largest collections of prehistoric remains ever assembled on one trip

that holes are worn through the hard, bright enamel. In each case, similar finds were removed from each other by a distance of five miles in a straight line.

Near a sample of such teeth as these, we unearthed the body of what must once have been a great chief. It was situated in a grave on the west end, buried in the conventional flexed posture, and had to be cut out of sandstone of rocklike tenacity. Between the hands of this skeleton, which lay on its face, was a large white spear-head. The rest of the day was spent in carefully sifting out of the sand hundreds of small, square abalone-shell beads and the larger pendants, from the quantity of which he must have had a coat sewn. Curiously, three other skeletons lay close to this one, all in a direct line, the head of each pointing towards the west. Only two skulls were brought in, however, including the first and that of a woman who had been interred with only a necklace of large reddish beads.

THE FIRST SKELETON DISCOVERED.
A number of stone accoutrements were found with these remains, which were disinterred on the west central plateau of the island.

Merely skimming the tops of those mounds that appeared to be less productive than others brought to light an almost unbelievable quantity of material. The amount of castaway shells and bones gleaming on the surface was also enormous. By crossing one of these great middens on hands and knees and using the eyes even casually many little shell fish-hooks, bone awls, harpoons, needles and the like were picked up. Sometimes on top of the mounds and sometimes on the sides were found bowls of stone and soapstone. Often these were revealed by a faint showing of the rim, to which they were buried in the sand. The larger mortars had to be dragged for miles on crude wooden sleds over the sands.

Great numbers of the relics found, especially the stoneware, were completely smashed. This work of demolition was undoubtedly carried out by the Indians themselves, and in a most businesslike manner. The queer religious beliefs of the ancient American Indians, often encountered among other aboriginal tribes in various parts of the world, may account for this wholesale destruction of personal utensils and household ware. It was thought by the old Indians that any implement a man manufactured was like himself possessed of a soul, or spirit. Therefore, when he died his bowls and other artifacts were broken and buried with him, or close to him. In this way were they "killed," so that their spirits might serve him in the next world!

Several different methods of effecting this breaking seem to have been practiced on San Nicolas. For instance, many of the bowls on the plateau were discovered with the bottoms alone smashed out. On the mounds toward the west end they were literally broken into the smallest of fragments. Others merely had a hole chopped into them. And in order to save themselves the labour of making new ones, later Indians utilized them by filling the holes with asphaltum, a tarry substance washed up on the rocks by the sea. One of the mortars brought in by the expedition shows a serrated line of chips around its rim, indicating the method by which they were sometimes demolished in a professional way.

At times a series of fragments were unearthed that would fit together perfectly to form a complete bowl. These were gathered up, the fragments numbered, and brought back for restoration at the Museum. But the old inhabitants of San Nicolas apparently foresaw that something like this would happen even to their broken utensils. Craftily they worked out a plan to prevent it. The archaeologist might find a broken mortar of ten pieces, nine of which went into place perfectly. The tenth would be a fragment of another bowl! And the missing piece was never found, which suggests that it was probably either ground into dust or thrown into the ocean.

For the first week or longer, everything come upon by the expedition had either been found before by some previous explorer or else was hopelessly scattered by sand and wind. Experience quickly demonstrated the futility of digging haphazardly. To turn up anything at all, surface indications must first be revealed. Otherwise one might dig on for ever. In addition, it was decided that it would be wise to construct several large screens to sift every inch of sand about a burial. This was a precaution taken

to save a skeleton down to the minutest beads and the smaller finger and toe bones.

The first complete and untouched grave was found on the west central plateau; the top of a bleached skull protruding above the sand led to its discovery. When dug out and developed the skeleton was found to be lying half on its side in a flexed position. The head was quite upright, having slipped with the shifting of the earth. The skeleton was that of a young man with a pronounced Mongolian cast of skull. A curious ossification had joined the pelvis together in one piece so that it resembled nothing so much as a saddle. Buried with it were a stone axe, two throwing-stones shaped like doughnuts, and a dish made of abalone-shell with the perforations plugged with the usual asphaltum.

THE HUNCHBACK SKELETON.
Each of the four complete remains was found to be diseased. The most interesting, archaeologically, was a hunchback.

On the west end of the island there is a great continuous mound, stretching out for perhaps a mile and sloping down into the sea. Its entire expanse is covered with the remains of Indian feasts, and in its interior are hidden their bones. Here protruding hip-bones revealed a grave that yielded one of the most unusual finds made on the island. The skeleton was the largest encountered, and upon closer inspection was seen to have a twisted spinal column, five of the vertebrae and the sacrum itself being ossified or grown together. A protective sheath of bone had extended over three of the vertebrae, partially joining a fourth. The skull was extremely large, as is generally the case with hunchbacks, while the sutures were grown together, indicating that he was an old man at the time of his death. The teeth showed considerable wear.

It is a noteworthy fact that of the many anatomists and medical men who examined this skeleton after it was brought back to the Museum, none have agreed upon what the affliction is, or even what caused it. Some were inclined to the theory that the aborigine had suffered a blow which broke his back, but that he lived through it, as shown by the subsequent overgrowth of protective bone. One physician claimed that it was a not unusual disease, and that it was not serious; in fact, he believed he suffered from somewhat the same thing himself. Finally, Dr. Roy L. Moodie, Professor of Anatomy in the University of Illinois, after carefully examining the skeleton, diagnosed the affliction as being tubercular.

Almost every conceivable question and angle in anatomy came up in the inspection of the bodies unearthed on San Nicolas. The only available way of distinguishing the sexes was from the shape and size of the various bones, the width and angle of the pelvis, the notch of the jaw, and the shape of the cranium. But it seems to have been a rule with the islanders to bury their squaws with a total lack of funeral equipment, though all the bodies were interred in some form of the conventional crouched or flexed posture, the knees drawn up under the chin and the arms clasped about them. One of the female skeletons was the only one which did not appears to have some affliction of the bones.

Two of the most unusual finds are the so-called "Cannibal Hole" and the "Artist's Mound." One member of the expedition discovered a deep grave on the north shore, near Coral Harbour. Because of the unexplained nature of its contents, this was rather facetiously termed the "Cannibal Hole." Passing through a layer of about one and a half feet of white sand, one and a half feet of black burnt midden, and two feet of a dirty brown sandy formation, he came to a red sand covering four *scapulae*, or shoulder bones of a whale, almost always a sure sign of Indian burial.

These were laid close together, and beneath them was a somewhat confused mass. Five skulls were set upright in a semi-circle, with three others on top of them. Discs of whalebone were placed against the faces of some, and under the jaws of three were found steatite pipes with incised designs. On the top of each skull was an abalone-shell dish, plugged with asphaltum. One skull had its mouth open, a shell-dish thrust between its teeth. At the side was a number of incomplete skeletons, laid out supine. In the centre, with the skulls, were a soapstone bowl, dish, shell-cups, bone implements of all varieties, a harpoon, several little images, and other parts of skeletons.

A child's skeleton was found here with the ribs arranged in a compact, unnatural position, many of the bones being missing. An adult skull lay in the centre of the mass, filled with small animal bones and human finger and toe bones.

Oddly enough, six bones were discovered that were subsequently identified in the Museum as the heel bones of deer. There were never any deer on San Nicolas Island, and furthermore these were the only parts of any deer found. The suggestion that possibly several haunches of venison had been brought over in an Indian canoe from the mainland is untenable. Doubtless they had some ceremonial significance, although it is well known that too often inexplicable phenomena are relegated to this class. At the bottom of this grave the skull and portions of a badly decayed, apparently much more ancient skeleton, were found.

THE CANNIBAL HOLE.

Four shoulder bones of whales covered the contents of this grave, found near Coral Harbour.

This was a most bewildering burial place, and its arrangement is difficult to account for. Perhaps it was only an old Indian re-burial. That is, it is possible that later islanders found the skeletal remains of previous ones and religiously gathered together the most important parts and buried them again. It may be that these later Indians put their own artifacts into the grave with the older ones, and probably they also reasoned that since it was apparently the wind which had uncovered these old bones, they would this time fool the wind by digging a deeper hole.

The material removed from this grave is now on exhibition in one of the cases in the Indian Room of the Los Angeles Museum. In this case there is also displayed the small image of a shark, carved in the round, which was found lying on a sand dune raised over the "Cannibal Hole" by a later storm. This shark was perhaps once traded to one of the natives who lived on the dune by the old artist whose studio is to be found on the midden known as the "Artist's Mound." This mound is located about a mile west of the first skeleton discovered, and leads up to a long slope overlooking the middens and sea on the western end of the island. The reason for its name is apparent from a study of the material found there, and from the fact that it is the only place on San Nicolas where traces of ancient incised art were found in any quantities.

First remarked because of the enormous numbers of broken fragments of mortars and pestles strewn over its surface, it was later made a special point of investigation when Mr. Hatton found a number of pieces that fitted together to make a complete soapstone bowl. Here there were all kinds of evidences of former expeditions, but the previous scientists did not seem to put much value in the broken material that lay about. They seem to have torn into the site in a reckless sort of way, flinging things they deemed worthless in every direction. It is on this mound that Mr. Ralph Glidden, curator of the museum on Catalina Island, is said to have excavated a wooden coffin containing the skeleton of a dog.

Excavating the "Artist's Mound" was a matter of sifting every foot. Here were found three fragments of a large stone hook-shaped implement, measuring some sixteen inches in length, and unlike anything ever seen before. The top piece was never found. There were also parts of a shield-shaped slab, very flat and nicely ground, with bevelled edges, which has since been completely restored. Its use, along with that of the hook, is too remote even to conjecture.

The first image portraying some form of life was found in one of the graves on the "Artist's Mound," in the form of two halves of a broken soapstone shark with sail-like fin. Other articles included half of a small whale image, the head of another shark, polishing tools, arrow straighteners, abalone knives, fish-hooks, beads, pendants, and numerous other trinkets the use of which can only vaguely be surmized. One of the most valuable finds here was a collection of the original fabric, woven of reeds and grass by the ancient islanders, that had been preserved by a coating of asphaltum and the extreme dryness of the desert sands. Although this mound was excavated with great care, it will doubtless still yield much in the future to some enthusiastic ethnologist.

Book Reviews.

Beyond Physics, or The Idealisation of Mechanism. By Sir Oliver Lodge. (Allen & Unwin. 5s.).

This would appear to be an attempt by that virile and learned physicist, Sir Oliver Lodge, to show that certain puzzling relationships—to wit, matter, life, mind, and the survival of personality—may possibly be connected through a third intermediary which is the same as that which underlies, or rather is thought by some people to underlie, the modern physical theories of energy and wave mechanics. It is a little difficult to understand for whom the book was designed. It cannot be primarily for physicists, because although the major portion of the work is devoted to a recital, albeit an able recital, of modern physical theory, yet this is a subject with which the professional physicist is thoroughly conversant. On the other hand, it is far too advanced and technical in this respect for the average amateur. Another alternative is that it is intended to show the physicist that psychic phenomena may lend themselves to investigation by conventional physical methods. There is a suggestion of this purpose in several places.

The author seems to be opposed to the idea that the science of physics should confine itself to metrical phenomena, and apparently would prefer that the physicist should take upon himself the spirit of adventure and go forth to test his weapons upon strange media. Sir Oliver believes that "the ether is utilized and impregnated with something that may be called Life and Mind *in excelsis*, that it is the home of the ideal and the supernal . . . the vehicle or Concomitant of Supreme Mind" (page 47). Further, he says, "I feel as if I knew that portions of the ether are, so to speak, individualized . . . taking on here and there identity or individual form." Again, "My own conclusion based upon . . . elementary facts is that Personality—when it exists—including Character and Memory, is certainly a persistent reality."

The book puts the physicist into something of a dilemma. He is accustomed to performing operations which have the nature of measurement. Certain groups of probabilities he deals with in statistical fashion, and calls them laws. When he deals with radiation and energy the most he will say is that these things behave as though they had their being in some queer medium. Some people, like Sir Oliver Lodge, call this the ether. As a matter of fact it was invented by a scientist as an assumption upon which to base a most valuable and workable scientific theory. All the phenomena, however, which the physicist relates to this assumptive essence, exhibit an extraordinary uniformity in their statistical manifestations. In other words, the laws which have been formulated as a result of their behaviour, have almost a universal validity. Surely it is asking the physicist to go a long way beyond his *venue* when it is implied that he should endeavour to measure diverse subjective phenomena on the poetical (not necessarily untrue) assumption that they have their being in the same hypothetical essence, which is so convenient as a background for the measurement of visible light and other ubiquitous experiences.

Ever since the time of the great Newton, physical science, by experiment and theory, has revealed more and more the wondrous order and beauty of the universe. Science will still advance and objective experience will extend; but, nevertheless, there is that inner consciousness of reality in man, that apprehension of God with its insistent urge to worship which seems to raise up an insuperable barrier between the spiritual and the physical. The mystical or spiritual side of man, appreciable as it is through the mind and unquestionably allied to it, seems to be of an entirely different nature to metrical things and by no means amenable to the same process of investigation.

Those of us who study physics in this generation have much for which to thank Sir Oliver Lodge. He is a great physicist and a great teacher of physics, and therefore it is difficult to assess correctly the purpose of this book. The author remarks on page 144 that his suggestion is "presumptuous and hypothetical"—even if this is so, it still remains that his great name commands the respectful attention of a large public. The book will probably have a large sale.

V. E. Pullin.

Human Speech. By Sir Richard Paget, Bart. (Kegan Paul. 25s.).

The first six chapters (126 pages) are the best part of this book and the most truly representative of the author. If we add the thirty-six pages of Chapters XI and XII, what the book gives us of value is a personal study of practical vocal acoustics with applications to the imitation of vocal sounds by mechanical devices. Sir Richard's conclusions are based on experiments with models and with his own vocal apparatus, his ear in most cases being the *experimentorum arbiter*. In the early announcements the title given was "The Human Voice"—a much better name for the book, as the subject matter is mainly acoustic. The double resonator theory of vowel sounds is dealt with mathematically by Mr. Benton in one of the eight appendices. But vocal acoustics, as Sir Richard himself points out, are not phonetics or linguistics.

The author, however, attempts to forge a link between his practical acoustics and what we may call his linguistics. The conclusion of his experiments is "that we unconsciously recognize the tongue and lip posture by their acoustic effects, and are primarily interested in the postures rather than in the wave form or tone colour which they produce." Few readers will feel "driven" to the conclusion that "in recognizing speech sounds the human ear is not listening to music but indications due to resonance, of the position and gestures of the organs of articulation" (page 126). It may hear both, but what it really listens to is the purposive social use to which the sounds are put. In the primary speech situation, all the senses are important, for meaning is as much a property of the situational context of people, things, and events, as of the sounds made and heard.

It is not clear whether this latest form of the mouth gesture theory, based on acoustics, is put forward to explain the fundamental nature of actual speech, or as a guess at prehistoric origins, or as a contribution to the study of meaning, or all three.

The pronunciation of the simplest word involves, besides certain areas of the cortex and related processes, the whole of the respiratory tract, the diaphragm and certain muscles of the abdomen. The whole of the respiratory mechanism and the larynx, in addition to the supra-glottal articulatory organs, are invoived in an integrated motor act. To suggest that the motor background of speech is merely the "under-studying" of manual gesture by "tongue tracking" and lip gesture is clearly unsatisfactory.

The author seeks to strengthen his case by excluding the larynx as a true organ of speech. Apart from the fact that it is

an articulating organ for the glottal stop and consonants with accompanying glottal closure, and for certain types of "h" sound, the larynx gives pitch, and the intonation of the voice is of the greatest affective value in our social life of which speech is the main directive function. Besides, pitch can have semantic and grammatical function, and thus be as essential a part of the framework of a language as the inflections of synthetic languages, composed of vowels and consonants. It would be quite impossible, for example, to give an account of the morphology and syntax of the West African Efek without regard to the varying pitch of the voice. As an explanation of the fundamentals of actual speech, the theory fails.

If students of psychology and language find the linguistic chapters naive and fanciful, they have their answer on page 171. "For flights of fancy we are all born fully fledged; but most of us moult early, and our first plumage is not renewed. Those who do not moult, are plucked before their education is completed." It is unfortunate for the author that most of his intelligent readers will have been plucked, and that the poets who have "Intimations" may neglect acoustics, even when presented as brightly and entertainingly as in this book.

J. R. FIRTH.

The Genetical Theory of Natural Selection. By R. A. FISHER, Sc.D., F.R.S. (Oxford University Press. 17*s.* 6*d.*).

Although this is obviously a first-class book of which the later chapters are brilliant, many will have great difficulty in following parts of it because it is written largely in the language of the mathematician. The author, himself a mathematician, admits in the preface that the book is hard reading, and he is, no doubt, thinking of those endowed with a mentality similar to his own. He suggests that the difficulty of co-operation between the mathematician and the biologist lies in "an enormous and specialized extension of the imaginative faculty which each has experienced in relation to the need of his special subject," an explanation which may not be regarded as satisfactory by those who recognize a basic difference between the mathematical mind and that of the ordinary human being.

The different outlook of the mathematician and the biologist is well exemplified by the author when he says "No practical biologist interested in sexual reproduction would be led to work out the detailed consequences experienced by organisms having three or more sexes; yet what else should he do if he wishes to understand why the sexes are, in fact, always two?" (p. ix).

A glance through the book suggests that only a few of the chapters are mathematical because comparatively few contain complex formulae, but anyone of the type I have called "ordinary human being" who has floundered into and got lost in, say, Chapter II, IV or V, will recognize the mathematical bias of the language of some of the other chapters. Perhaps this has been to some extent unavoidable but the author, unlike many mathematicians, shows that he is capable of writing what I may call plain English, especially towards the end of the book, and I feel that in places he has lapsed into "mathematese" when he might have avoided it.

Chapter I, on the Nature of Inheritance, is easy reading, and the argument is that blending inheritance does not exist and that all inheritance is particulate. Chapter II, on the Evolution of Dominance, is one which I feel might have been put in less mathematical language without spoiling the discussion. Chapter VI, on Sexual Reproduction and Selection, VII on Mimicry, and VIII on Man and Society, are much easier to read, and will be readily appreciated, while after that, with occasional lapses, the book is within the understanding of any educated person and will give food for thought to biologists in the widest sense of the term. The criticism of birth-control (Chapter XII) merits careful consideration, and although the rules for the foundation of an ideal society, suggested almost apologetically by the author, may be debatable, they should certainly be studied by those who are interested in the destinies of nations.

FRANK BALFOUR BROWNE.

Manual of Meteorology. Volume III: "The Physical Processes of Weather." By SIR NAPIER SHAW, with the assistance of ELAINE AUSTIN. (Cambridge University Press. 36*s.*).

Sir Napier Shaw's great encyclopaedia of meteorology continues to progress. Having outlined the history of the science in Volume I, and in Volume II summarized all known facts about the distribution of meteorological phenomena on the earth's surface and in the upper air, he proceeds in Volume III to seek the underlying physical processes which govern these phenomena. The subject matter is complex and difficult; there are gaps in our knowledge which make the treatment in places disjointed, but the style is everywhere very clear and Sir Napier has contrived, to the reader's great advantage, to replace much of the usual highly mathematical treatment by a wealth of diagrams.

The greater part of the book deals with the application to meteorology of two main branches of physics, wave-motion and thermodynamics. The discussion of wave-motion follows more or less along the customary lines—gravity-waves, sound-waves, atmospheric optics, and the problems of radiation—and is chiefly notable for its thoroughness. The chapter on refraction of sound-waves and zones of abnormal audibility is especially interesting; the latter phenomena have recently been the subject of much discussion and experiment, but it is shown that they are amply accounted for by a stratum of high temperature at great heights, the existence of which is supported by the phenomena of meteors and wireless telegraphy. These refraction phenomena are, however, somewhat of the nature of curiosities, which give valuable insight into the structure of the atmosphere beyond the reach of instruments, but so far as we know have little or no influence on the sequence of weather changes. With the two chapters on radiation we get to grips with the latter problem, which for practical purposes is all-important.

The discussion of the balance of radiation follows the lines laid down by the late W. H. Dines; it is extraordinarily complete, tracing in detail the vicissitudes of a beam of the sun's rays from the time it enters the atmosphere until it emerges again as dark radiation to space. Many quantities enter into the calculation, and the rapidity of recent progress may be judged from the fact that while thirty years ago we could only guess at the magnitude of these, the computed outgoing radiation from the earth, air, and clouds now balances the incoming solar radiation, computed quite independently, with an accuracy of two per cent. This chapter represents one of the little-known romances of science.

The seasonal variation of solar radiation, modified by the distribution of land, water, and ice, is of paramount importance in weather, and in the middle half of the book we are introduced to the *modus operandi*, the working of the atmospheric heat engine. Sir Napier's treatment is basically novel; even his vocabulary would have been unknown to an earlier generation.

For meteorological purposes the important quality of the air is not its pressure or its temperature, but a combination of both, its "entropy," a quantity which is proportional to the store of heat independent of temperature, and inversely proportional to the absolute temperature. The conception is difficult, but fundamental, for the distribution of entropy governs the stability of the atmosphere.

These brief descriptions do not by any means exhaust the scope of the book; there is, for example, a long chapter of great interest on "Electrical energy in the atmosphere," and in fact, the whole length of this review is much shorter than the table of contents. The amount of information packed into the volume is amazing. The excellent index alone covers twenty-three pages, and, looking through it, one would say that Sir Napier Shaw and his able assistant, Miss Austin, seem to approach the omniscient in meteorology. It remains only to add that the Syndics of the Cambridge University Press have done their share by producing a neat and presentable, if somewhat weighty volume.

C. E. P. Brooks.

British Documents on the Origins of the War, 1898-1914. Volume VI. Selected and edited by G. P. Gooch, D.Litt., F.B.A., and Harold Temperley, Litt.D., F.B.A. (H.M. Stationery Office. 17*s*. 6*d*.).

From the point of view of the general public, this latest volume of documents on the origins of the war will be of even greater interest than its predecessors. The period covered is the years 1907 to 1912, when the situation between England and Germany was distinctly strained and so many efforts were made by negotiation to relax the tension that existed. The series under review is being published in eleven volumes, of which seven have now appeared. It will be remembered that the decision to publish a selection from these official documents was taken in the summer of 1924 by Mr. Ramsay MacDonald, as Secretary of State for Foreign Affairs, and announced by his successor Mr. (now Sir) Austen Chamberlain later in the same year. Volume XI was published first, and dealt with the period 28th June—4th August, 1914. Volumes I and II began with the year 1898, when certain influential members of the British Cabinet, alarmed by the hostility of France and Russia, desired to substitute a policy of alliances for the traditional principle of "splendid isolation." They ended with the conclusion of the Anglo-French Treaties of 8th April, 1904. The first Morocco crisis of 1904-6 was the subject of Volume III, while IV and V described British relations with Russia (1903-7) and the Near East situation, taking the story right up to the close of the crisis produced by the Austro-Hungarian annexation of Bosnia.

In the years covered by the new volume, the main topics of discussion were the question of naval armaments; the possibility of limiting their increase by mutual agreement between Great Britain and Germany; and the German proposal for a political formula as a preliminary to such limitation. The Bagdad railway and the question of Persia were important subsidiary topics. The most serious attempts to solve these problems are to be found in the Bethmann Hollweg proposals of 1909, the Gwinner-Cassel negotiations which immediately followed, and the long drawn out discussion culminating in the Haldane Mission of 1912. During the year 1911 the important question of Morocco brought Great Britain and Germany to the verge of war over the crisis of Agadir. But this very serious incident did not in fact terminate the discussions on limitation of armaments, and is reserved for full separate treatment in the seventh volume to appear later.

Representative extracts from the newspapers have been given, and special care has been taken to reproduce the summaries of the German press provided by Sir Fairfax Cartwright, and the impression produced on English statesmen by these opinions. The German Emperor's views are reported very fully in many conversations with diplomatic and other representatives. Nearly all the documents in the present volume are now published for the first time.

The Magic of the Stars. By Maurice Maeterlinck. Translated by Alfred Sutro. (Allen & Unwin. 6*s*.).

Those who are acquainted with Maeterlinck's writings will expect to find here a poetical account of the marvels of the heavens; and in this they will not be disappointed. The book contains many attractive word-pictures. However, the author has not specialized in astronomy, and the volume is not recommended as adequate for those who desire a full and exact description of the sidereal systems in the light of the latest knowledge. There are many misleading statements. On page 26 we find the sentence, "In 1884 only eighteen stars of variable light were known, and these were watched by five observers." Actually the 1881 edition of Webb's *Celestial Objects* contains 134 variable stars, and that list did not include all that were then known. On page 32 we find "... this system, that as one solid mass turns in the direction of Capricorn, speeding through the celestial vault at the rate of 400 miles a second." This is misleading; the centre of rotation is not in Capricorn, but between Sagittarius and Ophiuchus, according to the latest computations; and the motion is not in the direction of the centre, but at right angles to that direction; nor does the rotation take place "as one solid mass"; the methods by which it was detected and measured depend on the difference of angular speeds at different distances from the centre. The same error is found on page 131, "... the Milky Way ... has been heading for the Capricorn at the rate of 450 miles a second." On page 122 it is stated of Mars: "It is almost certain that vegetation there can be none." It would be easy to enumerate many well-known Martian observers who hold a contrary view. On page 123 the diameter of the image of Mars in a certain telescope is given as two metres, instead of two millimetres.

The philosophy of the book may be described as depressing; on page 69 we read, "In a thousand million centuries all will be as it is to-day, as it was a thousand million centuries ago; as it was at the beginning—and there could have been none; as it will be at the end—and there can be no end." It is matter for surprise to find the author making this statement so confidently, seeing that in the list of authorities at the beginning of the book he gives pride of place to Sir J. H. Jeans, of whom he says (on page 17), "He is at present one of the leading exponents of astrophysics." Now Jeans is absolutely against the idea of the infinite duration of the universe either in the past or future. He assigns its beginning to an epoch some five to eight millions of millions of years ago, and predicts its end after a longer, but still comparable time-interval in the future. He compares it to a clock that is running down, and is unable to indicate any process by which the rewinding might be effected; he ascribes the continued shining of the stars to the conversion of matter into radiant energy, but shows the difficulties that

arise in postulating the reconversion of this radiant energy into matter.

It is probable that Maeterlinck's assumption of the past eternity of the universe is based on a desire to dispense with a Creator. Even he, however, is driven to adopt the conception of the presence of "Demiurges" (he adopts this word, used by the Gnostics of old). He makes a sort of god of the earth; thus he says on pages 80 and 81, "At its beginning it (the earth) was more intelligent than we shall be at its end. . . . There is not the smallest thing we know that the earth has not known these many thousands of centuries. . . . The earth contrived this brain of ours; and, to do that, it must of necessity have had a brain that was superior, just as a watchmaker must be more intelligent than his watches."

Elsewhere in the book the author refers with favour to the suggestion of Sir Francis Younghusband, in *Life in the Stars*, that the dawn of human intelligence may have arisen through communications sent by wireless waves, or in some similar manner, from other worlds. It is clear that, even if this were the case, it would merely shift the problem of the origin of intelligence back a step, without giving an adequate explanation of it.

A. C. D. CROMMELIN.

The Mechanism of Nature. By E. N. DA C. ANDRADE, D.Sc., Ph.D. (Bell & Sons. 6*s*.).

It is the business of a reviewer, particularly of "popular" scientific books, to say, in the light of his experience, exactly what he thinks of the book under notice, regardless alike of possible charges of either fulsomeness or rudeness. "The Mechanism of Nature" is one of the best books of its kind that I have ever seen. One other which occurs to me as a comparison is Sir William Bragg's "Concerning the Nature of Things," which approximates to the ideal presentation of scientific phenomena in popular language.

Judging by the large number of scientific books written for the delectation of the non-professional scientific reader, the demand for scientific knowledge must be both considerable and at the same time definitely uncritical; therefore it is a great pleasure to read such a book which is both interesting and accurate. Professor Andrade needs no introduction. He is a well-known and accepted authority on scientific matters. He is also an accomplished commentator on science in that he is an expert in the art of analogy which, when it is used with knowledge and ingenuity, is supremely valuable in this connexion. At the same time it is a dangerous weapon in the hands of the unskilful.

The book deals with fundamental principles in modern physics. After defining the nature and scope of the study of physical science the author proceeds to treat of energy in its various manifestations. He devotes many pages to a consideration of the various well-known forms of radiation, such as light, X-rays, wireless waves, and so on, and their generation is explained in terms of current atomic theory. Wave motion is treated in considerable detail and developed into a description of the modern subject of wave-mechanics due to De Broglie and Schrödinger. One particularly valuable part of the book explains black body radiation and its significance in the development of the quantum theory. This subject is rarely understood by the layman, who is frequently puzzled by the technical term.

The notion of entropy seems of late years to have emerged from its original quiet setting as a somewhat special mathematical expression pertaining to thermo-dynamics, and to have achieved almost a fundamental position in the limelight of modern philosophy. The conception is not an easy one for the non-mathematical reader, but Professor Andrade succeeds in conveying quite a valuable idea of it in picturesque and graphic terms.

I am glad to notice that the author frequently emphasizes the statistical nature of physical laws, a most important aspect of science for the layman, by means of carefully chosen and apt illustrations. The book will be read with great interest and profit by all who are interested in the progress of modern science, and unlike many popular books it will be thoroughly enjoyed by the professional man of science whose business in life it is to learn.

V. E. PULLIN.

Orokaiva Society. By F. E. WILLIAMS, M.A. With an Introduction by SIR HUBERT MURRAY, K.C.M.G. (Oxford University Press. 25*s*.).

The Orokaiva occupy the greater part of the northern territory of Papua, and the present volume, the author of which is Government Anthropologist, is the tenth published report of the Papuan Government on anthropology. In his introduction the author dwells upon the advantage from the practical point of view of his studies in the administration of the native of New Guinea. This is a point of view which cannot be impressed too often upon the public at home, in presenting material dealing with the customs and beliefs of the primitive peoples under our rule, especially at the moment. A public opinion more fully informed as to the racial problems of India might have done much to lighten, if not avert, our present difficulties. Mr. Williams' book is not entirely local in its bearing, although he has had the needs of his fellow officials prominently in his mind. It is true he has confined his work almost entirely to description, and has, generally speaking, refrained from interpretation, but at the same time his work has a wide appeal, both in the range of its subject matter, and in its value for comparative study. The Papuan native is among the most primitive of peoples now surviving, and for comparative work, their social organizations and ritual practises are of first-rate importance.

Three of Them. By NORMAN DOUGLAS. (Chatto & Windus. 6*s*.).

The title suggests many things, but the book is so named because it includes three essays written in 1920, 1901 and 1891, two of which, perhaps all three, appear for a second time. "Nerinda" and "One Day" are written in an obscure style which, using a term usually applied to pictures, I should call "impressionist."

The earliest essay, "On the Herpetology of the Grand Duchy of Baden," was originally published in the *Zoologist*, where it appeared during 1891 in seven sections under the authorship of G. Norman Douglass. This was an excellent account of the reptiles and amphibians of Baden, their distribution, habits, and the nature of their habitats, with occasional reference to general questions such as the causes of melanism, of isolated areas of distribution, etc. But although the paper was no doubt of considerable value at the time of its first appearance, it is now thirty-nine years out of date. It is, however, interesting as showing a complete change of style on the part of the author.

FRANK BALFOUR BROWNE.

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